THE

ENGINEERING MAGAZINE

VOL. II. DECEMBER, 1891. NO. 3.

AMERICAN SUPREMACY IN APPLIED MECHANICS—I.

By Coleman Sellers, E. D.

AMERICAN supremacy in some branches of applied mechanics is generally admitted. It may in justice be claimed for others less known, and is not the work of a few years. The conditions leading to this result began with our freedom as a nation and have become more favorable with our growth. The Bulletins issued through the Census Bureau at Washington tell us of our numerical strength, now given as 62,622,250 souls, but they have not as yet fully expressed our manufacturing strength in the direction of applied mechanics in the past decade, if we except the interesting data in relation to street-railroads operated by cable, electricity and animal power. The final report will give what is yet lacking.

To note the character and point out the rational and scientific causes of the claimed superiority need involve no foolish boasting as to what has been accomplished, as it may be shown that this superiority is the result of well-defined laws, influenced by our geographical position, our form of government, the character of our people, as to their habits and the source from which they have sprung. It may be shown, and this is of more importance, that the supremacy is the result of circumstances over which we have some control.

Climatic conditions have favored a nation made up in the first place by enterprising immigration from the older countries. Our nation began with individuals who, breaking away from religious

Copyright, 1891, by The Engineering Magazine Company.

and governmental persecution at home, sought freedom that was to be had only at the cost of personal sacrifice and great danger. Freedom so dearly bought is now seemingly self-sustaining, with a people who are individually law-abiding, industrious, and rapidly rising in the scale of mental culture and civilized refinement.

The time is approaching when there will be gathered together in the great Western city of Chicago, itself one of the striking instances of this progress, examples of applied mechanics, the products of manufacturing establishments of all parts of the civilized world. We may expect then to see displayed in force the result of the ingenuity and industry of the American people. In anticipation of this it may be interesting to study some instances of the progress of applied mechanics in connection with the conditions that have favored this progress as observed and understood by one of the many who have passed their lives contemporaneously with the progress of the locomotive, and who have followed professionally the changes that have been wrought by the rapid intercourse between nations both as to mind and matter, and who are still interested in the advance of the United States.

Each such exhibition of the industries and arts held in America has not only furnished much valuable information to the world at large as to our national progress, but has in a marked degree given impetus to further improvements. The exhibition in Philadelphia, at the end of our first hundred years of life as a nation, marked an era of phenomenal mental activity and dated the beginning of greater wonders. One Sunday in 1876 at a private exhibition of some of the surprising things presented for the first time to the public, it happened that the attempt, as then believed the first, to transmit the human voice over the telegraph wire, met with a partial success. Those who were present could have no conception of the flood of light that would be shed upon the world during the next decade and a half by Bell, Gray and Edison. It has mattered little that Philip Reis in 1861 claimed to have improved Page's discovery of 1834 and made a telephone that transmitted words. To those who succeeded must be given the credit they so fully earned, as in America the state of the telegraphic art was most favorable, and from America has gone out over the world this surprising outcome of American minds.

The early English-speaking settlers in the United States, more especially those that landed north of Mason and Dixon's line, were not all agriculturists; many were artisans and in the new settle-

ments found abundant occupation for their manual skill. Our mother country looked upon her colonies as a possible market for her own manufactured goods, and aimed to encourage agriculture and mining in the colonies and to build up a trade founded on the exchange of food and raw material from the colonies for the manufactured goods produced in Great Britain. This condition could not be maintained in our case on account of the natural advantages offered to manufacturing in a land so rich in resources. When these states separated themselves from the mother country they found themselves rich not only in coal, iron, and all that is required to supply human wants, but found themselves strong in mechanical ability. They naturally turned their attention towards utilizing the many material blessings heaped upon them by a bountiful Providence; with what result is now quite evident to the world at large. The inherited manual dexterity of the early settlers became quickened in the rough contest for existence in a new country, and their inventive faculty was excited by the circumstances that compelled mental exercise in that direction.

OLIVER EVANS.

It was perhaps on the whole fortunate for our arts and sciences that the United States upon separation from Great Britain adopted the republican form of government. Such a Republic may be considered as one vast industrial enterprise which in some measure partakes of the nature of co-operation, the people themselves being pecuniarily interested in the success of the enterprise. It so happened that this form of government, tried for a century in the United States, has yielded good results, mainly because the location in which the experiment was tried possessed natural advantages favorable to the experiment.

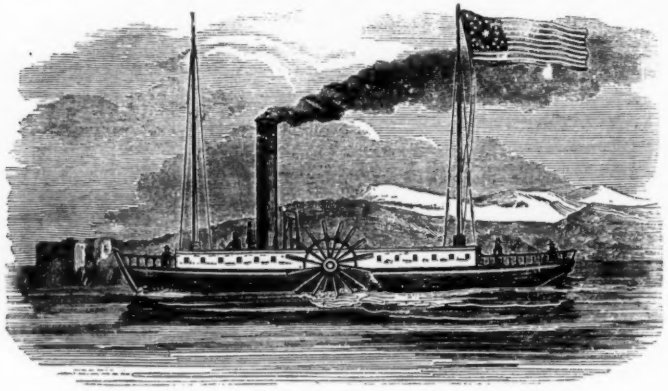
Active manufacturing began here untrammelled by any previous trade rules or existing manufactories of any kind. The marked progress in the arts and sciences has all occurred with us and with other countries older than ours within the last hundred years, and it should therefore be reasonably expected that progress would be

* Oliver Evans, born in Delaware, 1755, died, 1819. Built the first high pressure steam engine and applied it to flour-milling; also the first steam-dredging machine in America and the first steam land carriage.

most rapid where opportunity for progress is greatest, where the wants are greater, where more has to be accomplished and less has already been done. The knowledge required for doing what was wanted in the beginning was identically the same in both the old and new countries. It was the same people in different localities with different instincts to guide them. With our great natural channels for navigation staring us in the face, Fulton had more to excite him to enterprise on the banks of the Hudson than he would have had on the banks of the Thames.

The charter granted for the first railroad in England was followed so speedily by similar enterprises in this country that the race for precedence in regard to land transportation was started fairly with but one disadvantage on the side of America, and that was the immensity of the country and the small amount of capital available for the purpose. This, while it led to a more shiftless method in the beginning, resulted through the survival of the fittest, in an independent line of invention born of the necessities of our case and developed by the need of rigid economy in accomplishing the result.

As our field afforded the widest field for Fulton's enterprise so our railroads in time came to excite the inventive faculty of Pullman and others to aim for comfort and end by reaching luxury. Pullman coaches—a necessity in America—may be adopted in other countries, but they would not have originated where the exciting cause did not exist. The dangers incident to American



FULTON'S FIRST STEAMBOAT.

railroads were lessened by Westinghouse, who found tardy recognition of his air-brake where conditions had to be altered to make it available.

Switzerland tried experiments in the transmission of power to a distance by wire rope, and in Switzerland and the countries near by the transmission of power from some common source is being rapidly developed for local reasons. Switzerland is great in its manufactories of turbines; more so than Great Britain. There are more waterfalls to be improved in the one country than in the other. England is rich in her coal-beds. Coal can be transported by boat or by rail and at the end of the journey will yield as much power per ton as such coal would at the mines from which it was taken.

ROBERT FULTON.*

Water close to its source gives power, provided there is a difference of level. Water alone, unaided by heat to convert it into steam, is not capable of furnishing power unless the water is so situated as to permit the exertion of its power through gravity, so that while coal will give power wherever it is burned, water by gravity will yield power only under certain fixed conditions. Switzerland is rich in water-power because rich in water as a source of power, existing on the tops of mountains. The glaciers that are yearly visited by so many tourists are continually sending down into the valleys streams of water which may appear but as tiny rivulets, but these rivulets, owing to the height from which they fall, are capable of exerting a large amount of power, so that Switzerland's glaciers, with the development of their power and its transmission to a distance by electricity, become to that country veritable coal-beds, lighting, heating, grinding the corn and weaving the cloth of the country. Switzerland, with the attention of its engineers directed to development of this kind, must be prominently forward in the march of improvement from the necessity of the conditions which excite its inventive faculty.

---

* Robert Fulton, born in Pennsylvania, 1765, died 1815. At the age of thirteen he built paddle-wheels for a fishing boat. He became a miniature painter, and while studying art in England patented a double inclined plane, for canals, a mill for sawing marble, a flax-spinning machine, a dredging machine, and several boats. He returned home in 1806, and in 1807 his first steamboat, the *Clermont*, appeared on the Hudson, the result of fourteen years experiment.

This one example is sufficient to show what is the case over the entire face of the globe. The country that is most rich in natural resources and the home of industrious, intelligent people, naturally takes the lead in the march of progress in any particular industry, and the fortunate circumstance that brought together the various States of the United States into one confederation without any commercial restrictions over its entire immense area has materially hastened this progress in the United States in certain directions.

The older countries, cultivated through thousands of years, may be rich in monuments of antiquity and may show roads marvellous for their engineering excellence, but many of those roads are the direct result of the needs of a people governed by force. The Roman empire built roads that after a lapse of eighteen hundred years are yet to be traced through Great Britain, not for the accommodation of the people of Great Britain but to enable the Roman legions to subdue that nation. With the immense standing armies of Europe, the transport of troops becomes a prime necessity. Roads must be in fit condition for this purpose and it is by the necessities of war that results are reached offering some slight redeeming feature in the lasting engineering works that have resulted therefrom.

America without a standing army, gains to the active laboring population many of those who would otherwise be under arms, saves the expense attendant upon keeping up these heavy military organizations and becomes the more desirable home for those who would leave their fatherland to avoid military conscription, for in such a case as this it is not cowardice that drives the man from home ; it is the desire for liberty, to work in the support of himself and his family. This it is that has brought to this country so many from all countries who are now identified with our progress. What has been done to advance the arts and sciences here has been brought about in many cases by men from other countries who saw in America possibilities that did not exist at home, and where they were assured of more remunerative employment for their exertions than elsewhere.

It was not until the end of the eighteenth century and even well into the nineteenth that manufacturing as it is now understood began to be organized, and machinery increased with the available means of actuating it. The high-pressure steam engine was adopted in the early part of the present century, almost simultaneously in England and America, and it was not long before the impress of

the American mind became apparent in the growth and development of the higher type of these machines.

Man's wants suggest inventions which local conditions favor. The necessity of providing against fire in the wooden towns of the new States developed the manufacture of improved fire-engines at an early period, and for the use of these engines riveted leather-hose, an American invention, ranked first in utility until the American Goodyear vulcanized India-rubber came into use. At the present time the production of steam fire-engines is acknowledged to be an industry peculiarly American.

ELI WHITNEY.

On April 10, 1790, an act to promote the useful arts was passed by Congress on authority of a clause in the Constitution of the United States where, in Section 8, Article 1, is to be found: "That Congress shall have power to promote the progress of science and useful arts by securing for limited terms to authors and inventors the exclusive right to their respective writings and discoveries, etc., also to make all necessary and proper laws for carrying into execution the foregoing power." It thus came to pass that a patent system, in the main so satisfactory during its century of trial, came to take the place of patents granted by governors of individual states. Between 1790 and 1800 the number of patents issued were few, but some of the earliest ones were indicative of the capacity of the people.

COUNT RUMFORD.*
[Benjamin Thompson.]

Poor John Fitch took out his patent for propelling steamboats by steam in 1791, as did also James Rumsey, while Jehosophat Starr followed with a similar invention in 1797, but Robert Fulton, whose name has been so familiar to the world as the successful introducer of steam navigation, took out his first patent in 1811, while John Stevens made and operated a screw propeller

* Born in Massachusetts, 1753, died in France, 1814. Early devoted his attention to science, distinguishing himself particularly in relation to the nature and effects of heat.

long before the great inventor, John Ericsson, thought of that mode of propulsion.

In 1820 Thomas Blanchard, who was born in 1788, took out his first patent for the lathe for turning irregular forms, and this patent was extended by act of Congress in 1843, giving birth at that time to one of the most far-reaching inventions, one that laid the foundation for all the wood-working and metal-working machinery that has since been devised for operating irregular forms. Nothing could be more distinctly American than were the inventions of Blanchard.

The story, too, of Eli Whitney, the inventor of the cotton-gin, carries with it a useful lesson. Born at Westborough, Worcester County, Mass., December 8, 1765, descended from an ancestor who came to America in 1682, and of whom it is said that he, the youngest son of a well-to-do Englishman, came at his father's suggestion, who was convinced that America was to be a great country. This father is said to have called his sons together and promised to the one who would go to America in his place, he being too old to emigrate, a double portion of his property. His descendant, Eli Whitney, was not educated a mechanic. He was a graduate of Yale and was to have been a teacher, but he was naturally fond of the use of tools. During the Revolution he made iron nails when nails were at a premium, before the time of the invention of cut nails, one of the most distinctly American lines of industry that was afterwards created. When the problem was presented to young Whitney to devise some means of separating cotton from the seed other than by the laborious process of picking it by hand, his study resulted in the invention of the cotton-gin, which machine, perfect in principle in its first conception, changed the whole character of agriculture over the Southern States and brought wealth to the people, as it was said, to quote the language of Judge Johnson in 1812: "If we should assert that the benefits of this invention exceeded $100,000,000, we could prove the assertion by correct calculation, and that there was no probability that the patentee, if the term of his patent were extended for twenty years, would have obtained for his invention one-half as much money as an individual will gain by the use of it. For up to that time the whole amount of what he had acquired from his efforts, after deducting his expense, had not exceeded one-half the sum which a single individual has gained by the use of the machine in one year. This was the invention that had trebled the value of the land over a large extent

of territory as it was considered at that time, and species of cotton were introduced that were never known as an article of commerce until this method of cleaning was discovered."

While this relates to the condition of the art brought about by Whitney's invention as it impressed those who lived in 1812, the very men whose wealth had been acquired by the use of the machine and had grown rich beyond all former examples, combined their exertions to prevent the patentee from deriving any greater emolument from his invention.

THOMAS BLANCHARD.

The late Mr. Joseph Harrison, Jr., after his return from Russia with an ample fortune, delighted to tell the story of the Russian engineers sent out to study railroad engineering, passing through England, attracted by what was being done in the United States. They selected his firm and its inventions and gave to Eastwick & Harrison a contract for building locomotives for the new railroad service in Russia. In his home in Philadelphia Mr. Harrison exhibited a painting by Schusselle, representing a blacksmith seated at the right hand of King Solomon's throne. The picture illustrates an event in the feast given by King Solomon at the completion of the temple. To this feast had been bidden, they say, the architects and the officers of the government, the great painters and decorators that had had to do with the ornamentation of the work; those who had helped to shape the gold and silver and carve the ivory and weave the costly hangings that decorated the walls. To the feast came unbidden and unrecognized the swarthy smith, forcing his way through the courtiers to the throne of the king,

ELIAS HOWE.*

* Elias Howe, born in Massachusetts in 1819, died 1876. He worked with his father, a farmer and miller, going to school winters. Working in a Boston machine-shop he invented the sewing-machine, which a school-mate helped him to patent. Laborers opposed its introduction and Howe turned railroad engineer. He went to England, but returned poor, having sold his patents. In the meantime imitations had been made, but in 1854 he established his right to the invention.

claiming recognition as the one to whom was due in a great measure the possibility of the entire work, as his skill had rendered other work possible. He it was who had forged the tools for all the other workmen and artisans, who acknowledged that without his help they could have done nothing. The wise king, recognizing the justice of the claim, gave to the smith the seat of honor.

From the smith of King Solomon's day to the mechanician of the present time, working in close connection with the metallurgist, there were centuries of manual skill displayed in works of art, passing in all countries through periods of rise and fall, just as the lacquer and bronze work of Japan can be traced from the mythical past to the period of greatest perfection on the threshold of ancient written history, to decline with the nation's decline, to rise again, always influenced by the state of education and the nature of the government.

BENJAMIN FRANKLIN.*

Toiling millions set by hand the great stones that still mark Egypt's greatness. Toiling millions may have been sacrificed to rear the Pyramid of Gesha, burying in that one pyramid alone the stone that could have reared a wall around the coast line of England stronger and higher than those yet standing about Chester and York, rendered useless in modern warfare. Granite can no longer stand against the great engines of destruction that may make war no longer possible, and the modern soldier seeks shelter beneath the primitive earth-works of the mound-building nations as his best defense.

The mind now is called upon to direct the hand and to direct the forces that are being trained to be the servants of mankind. The mind has in fact more to do than the hand. The modern iron-master is not what he was forty years ago. The steel-makers, so celebrated through empirical methods handed down from father to son, have been unable to guard their well-kept secrets. The chemist has analyzed the metals and has shown how the best results can

* Benjamin Franklin, born in Boston, 1706, died 1790. This statesman, diplomatist, philosopher, moralist and wit was also an inventor. One of the great discoveries of the eighteenth century, that lightning is a discharge of electricity, is his. Ten years earlier he invented the open stove. He founded the American Philosophical Society and the University of Pennsylvania. On a voyage to Europe he completed notes upon the Gulf Stream which are the basis of the present charts.

be obtained by mixing in proper proportion with the iron the brittle-making and strength-giving qualities of carbon; has fixed the positive values of silicon, of phosphorus, of sulphur, and found out how to use what makes or mars his mixture of metals; how to raise or lower the freezing point of the fluid metal mass; doing all this in the wilds of the great West and in the sunny South as well as in Damascus or Sheffield. The mechanical means of accomplishing all this comes with a full knowledge of human wants. Growing necessities quicken the inventive faculty. What we cannot make for want of proper tools will suggest devising means of accomplishment.

THOMAS A. EDISON.*

In the biography of the late James Nasmyth, the originator of many machine tools, can be found a reproduction of a page from his notebook, showing his conception of the steam hammer. It is said that this page and his thoughts on the subject were imparted to some visiting French engineers, who, taken with the idea, built the first direct acting steam hammer, and acknowledged the source of their inspiration. The steam hammer became a necessity with the growth of steamships. As constructive engineering called for larger masses of forged metal, the power of the crude forging machinery of an early date was soon found to be inadequate. The growth of the machine tool industry may not have been in advance of the requirement of the time, but its growth is a necessity as lying at the bottom of mechanical

JOHN ERICSSON.†

* Thomas Alva Edison, born in Ohio, 1847. At twelve he was a newsboy on the Grand Trunk Railway and made chemical experiments in the cars. He was an eager reader, and printed a little paper. A station-master, whose child he had saved at the risk of his life, taught him telegraph operating. About 1872 he perfected his duplex telegraph, and invented a printing telegraph for stock quotations. His greatest invention is the subdivision of electric light. In 1877 he invented the phonograph.

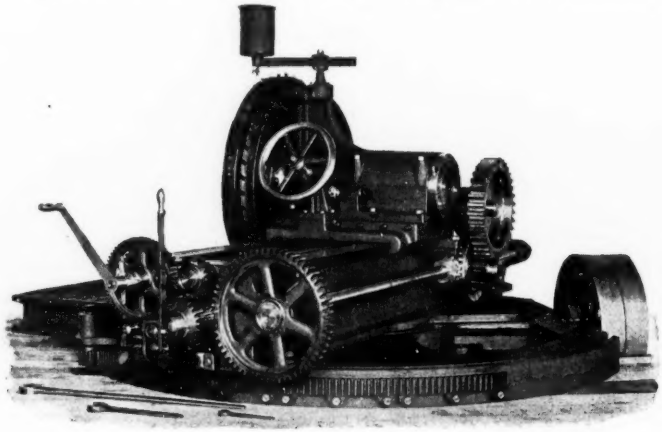
† John Ericsson, born in Sweden in 1803, died in 1889. At the age of ten he made a saw-mill. His inventions include a line engraving-machine, a hydrostatic weighing machine, one for condensing steam and returning the water, a self acting gun-lock for war vessels, a steam fire-engine, a caloric engine, and a boat with propelling machinery below the water-line. This last invention, with a revolving turret, he applied to the *Monitor* in 1862.

progress in supplying the means to accomplish not only its own production but all the machinery that is required for each and every industry in the world.

Great Britain is undoubtedly the birthplace of the modern machine-tool industry. Sir Joseph Whitworth is justly credited with having originated a style noted for strength and simplicity of design, for accuracy of workmanship and absence of all useless ornamentation. Previous to his effort, shapes well enough in carpentering work and architecture, the building of houses, were forced to do service in mechanical productions and all kinds of machines, steam-engines, machine-tools, wood-working machinery, etc., had their framework made in fancy forms and decorated by elaborate coloring when finished.

The progress of a nation can be very well followed by noting the character of the tools required in prosecuting the manual labor. The crudest agricultural methods are coupled with primitive plows and other implements of the husbandman. There is an old saying that a good workman requires but few tools, and the most elaborate kit collected by a modern enthusiastic carpenter when beginning his trade, may be no indication of the workman's skill; but on the other hand the workman who has added to his stock of implements new though simple aids, is apt to be the one who can do the best work the most rapidly.

The United States is now being recognized as particularly



ROTARY PLANING MACHINE.

strong in its machine-tool industry, not only in regard to the higher class of lathes, planers and boring-machines, but in all the minor hand tools, measuring devices and graduated scales, and in the many productions that were but a few years ago to be had only from importers, poor in quality and in design.

GEORGE M. PULLMAN.*

The fundamental principles that underlie the theory of construction of machine-tools have been studied by the American engineers, incited by the necessity of doing good work in large quantities through the instrumentality of only moderately-skilled workmen whose wages are high. It would be invidious to point to any one man or any set of men as presumably the originators of what is theoretically good in our application of the laws of physics to our embodiment of these laws in labor-saving machinery, nor will space permit the explanation of how correct principles introduced little by little have been accepted by all and thus in time become characteristic of our designs.

SIR WILLIAM G. ARMSTRONG.†

That our machine-tool makers have produced labor-saving machines capable of doing the best work with less skill on the part of the operatives is acknowledged by the acceptance of such machinery as models in older countries where in some cases still greater improvement has been made, while in other cases the best features have been lost through the failure of the copyist to grasp the theory of the conception and to understand the motive or aim of the originator.

---

* George Mortimer Pullman, born in New York State, 1831. At fourteen he was clerk in a country store; at seventeen in his brother's cabinet-making business. At twenty-five he took contracts for moving warehouses for the widening of the Erie Canal. He first applied machinery to raising whole blocks of stone and brick buildings, notably in Chicago. In 1859 he began the experiments with railway coaches which resulted in the sleeping, drawing-room and vestibule cars of to-day.

† Sir William George Armstrong, born in England, 1810. He was studious but to please his father devoted himself to mechanical pursuits, giving his leisure to science. He invented, 1838, an improved hydraulic engine. In 1842 he perfected an apparatus for producing electricity from steam and established the Elswick Iron Works. During the Crimean War, 1854-55, he invented the rifle cannon that bears his name. He was knighted and made chief engineer of rifled ordnance.

The work done in other countries by the distinguished engineers whose names are coupled with modern progress in applied mechanics, leaving its impress upon American minds and being adopted in America, has seldom been copied in its entirety. What may be very good in design and in principle requires changes to meet the wants of other people. These changes are not made for the sake of change, but for positive improvement.

In tracing the adaptation of what has become classical in mechanics, originality cannot always be claimed by those who have perfected, introduced and induced others to adopt contrivances. Many inventions perfected here can be found outlined in early English patents that have been dead for years. This is notably the case with wood-working machinery, but cannot in any way detract from the credit due to those who have perfected these machines on new lines and originated them entirely independent of suggestions that had never been carried out and unknown to the modern authors. Given any problem in mechanics to be solved, and many separate inventors will solve the problem in the same manner, the differences being due to difference in "mechanical vision."

JACOB PERKINS.*

The theory and practice of self-adjusting journal bearings with extended surface for wear as applied to transmission of power by line shafting so well understood in America and so universally followed, is one of the most striking peculiarities of American design. Few English inventions brought to this country are merchantable until they are Americanized, simplified, made accessible in the case of machinery, and constructed with a view to ease of repair as well as to durability when under the care of careless attendants. The solidity and immense weight that some deem a merit in English machinery is not in our opinion worthy of copying.

* Jacob Perkins, born in Massachusetts, 1766, died 1849. At fifteen, while a goldsmith in his native town, he invented plated shoe-buckles. He was employed by the State to make dies for copper coinage, and invented the substitution of steel for copper plates in bank-note engraving. In 1818 he went to England, on contract to supply the Bank of Ireland with steel plates. He originated a process for transferring engravings from one steel plate to another.

[*TO BE CONTINUED.*]

A PERMANENT CENSUS DEPARTMENT.

By Edward Atkinson.

WHILE this subject may not appear to be directly connected with engineering, yet without the work of the engineer the application of science to the arts of production and distribution would have been possible only to a very limited degree. Coincidently with the application of chemistry, electricity, and other sciences to agriculture, mining, metallurgy, and all other arts, has grown up a necessity for a development of engineering science, to the end that the very benefits of other improvements might be enjoyed by man. Thus it has occurred with this general development that engineering has become specialized, and we now have in the schools the several departments of civil, mechanical, marine, electrical and chemical instruction, qualifying engineers in each of these branches of science so that they may be prepared to take up their several lines of usefulness to mankind. After the work of all but the civil engineers has been exhausted, it has been through their intervention that the world has become a neighborhood ; that distance has been reduced to the fraction of a cent a ton a mile, and that even a ton of food may be sent around the world in eighty days or less without exhausting the value of some of the finer types of the produce of the field. In this view of the case the topic chosen for this paper may rightly find a place in a magazine devoted to industrial progress.

Whatever may be the ultimate verdict as to the conduct of the United States Census of 1890, one inquiry has been entered upon by the Superintendent that may lead to beneficial conclusions. He has been asking many persons as to the advisability of establishing a permanent Census Bureau, calling for suggestions in connection therewith. In reply to this inquiry the following suggestions have been made by the writer; they are submitted in the present form for the reason that the suggestions offered may have a bearing upon other work of like kind which is now in progress. For instance, reports may be expected to be issued soon by the Government, prepared by the Commissioner of Labor, on the relative cost or wages of labor in this and other countries.

Again, the Finance Committee of the United States Senate, under the order and authority of the Senate, are now occupied in

an inquiry upon the subject of the relative prices of various products of industry in this country that may or may not have been affected by legislation in a series of years. Enough is known of the history of prices to make it apparent that the results of the investigation undertaken by this Committee will bring into the form of absolute proof certain important facts. Let it be assumed that the investigation of the Committee covers the period of forty years from 1850 to 1890. It will then include the effects of the great addition of gold on the circulation of the world through the opening of the mines in California and Australia, and it will also measure the influence upon prices of the more potent factor of reduction in the cost of distribution through the development of railways and steamships. The general results of this investigation may be laid down *a priori* substantially as follows:

I. Wherever the railway and steamship have penetrated there has been a great tendency to the equalization of prices; distance has ceased to be a prime factor. There are no longer regions and sections of excessive product and very low prices, with corresponding sections affected by scarcity and very high prices. The world has become a neighborhood, each community serving the other according to its needs.

II. In respect to almost every important staple, except products of the forest, it will be proved that while prices have been equalized in very great measure, the general tendency has been to a reduction in prices here and elsewhere. The quantity of labor in production has been diminished; the hours of employment have been shortened; the prices or wages of labor have increased, while the price of the product to the consumer has been diminished.

This sequence or order will be proved to apply most fully to those industries, like metallurgy or textile-manufacturing, in which science or invention have been most effective.

III. The deductions which may be drawn from the necessary conclusions of such an investigation doubtless will be cited by men of opposite political parties either to sustain or to condemn each and every system of taxation; each and every system of banking; each and every variation in the kind and quality of the currency that has been in circulation in the United States in any part of this period. In other words, no absolute conclusions can be drawn from them. Thus, while the results may be of the greatest possible help to the student, they may have very little value in political and financial discussion; the forces which really govern

prices being more potent than any kind of legislation on tariffs, banking or currency, except an absolute and unqualified depreciation of the unit of value.

IV. Nevertheless, this investigation is one of the absolute requirements for any intelligent discussion, either of taxation, currency or banking. The one element which will make this investigation complete is to establish what I have named in the conclusion of this communication as "a science of the comparative statistics of nations."

During this period of forty years prices and wages in this country have been affected by changes in the tariff and by very great changes in the standard of values. In Great Britain prices and wages have been very greatly affected by the completion of the changes in the tariff system of that country begun in 1842; they have also been affected by the maintenance of the gold standard in Great Britain, while India has been subjected to the free coinage of silver. Prices and wages have been affected in France by somewhat similar changes, but of less moment. The condition of Germany has also been affected by a different policy. What absolute prices might have been if unaffected by legislation elsewhere, may be found in the best list of prices yet attainable—that which has been maintained in the free port of Hamburg.*

It will be manifest on this whole statement of the case that, in order to measure the influence of special factors such as changes in a tariff, which affect prices and wages in some degree, *there must be a complete and adequate comparison of the relative prices of products and of wages in each country throughout the period named;* so that, by comparison, the relative effect of the changes in the tariff, banking and currency systems may be determined. It is to be hoped that this matter of the relative or comparative prices will be covered by the report of the Finance Committee in order that the foundation may be laid, not only for the establishment of, but also for the method of service of a permanent Census Bureau.

Without such permanent organization and without such continuous and consecutive work by a well-organized permanent Census Department the results of the Census as now taken must be of comparatively little value as a guide either to the student or to the legislator. For instance, among the data of the Census there is nothing more often quoted than the progress of this country in

*This list of prices was reprinted in my report to the President upon Bi-metallism, published by the State Department in Washington.

the arts which are listed under the head of "manufactures," yet nothing could be more fallacious than the ordinary deductions from the totals. No two of the compilations of the last four or five decennial periods have been made on the same forms. A considerable part of the apparent progress, therefore, grows out of the inclusion of branches of industry in the recent compilations which were not included in the earlier ones, or which were included under such entirely different conditions that the comparison by periods is wholly vitiated. Thus, meat-packing now forms a very large element in the compilation of capital, of men employed, and of product in quantity and value. In former days a larger amount of work was done relatively to the quantity of products than is now necessary in this art. It was done, however, by the local butcher and was not included in any considerable measure in the column of manufactures. Its inclusion under the head of manufactures duplicates that which is a very essential part of the product of agriculture, and thus shows a gain which would mislead the student who does not know how to take the Census figures to pieces and adapt them to the actual conditions of life. Again, the inclusion of sugar-refining as a department of manufacturing swells the total, when in fact the added value is but a fraction of the product which is listed primarily and mainly as an article of import.

If the Census Bureau were permanently organized a system would be established for separating, classifying and listing each product in its right place, thus avoiding the duplications which swell the volume of figures but totally mislead one who is in search of the facts. Moreover, I suppose there are very few persons who are familiar with the compilations of statistics who have not reached a condition of very profound distrust of the deductions which may be drawn from great averages covering very wide areas and very different conditions, even in respect to the same product. The trained and permanent employés in a continuous Bureau would qualify the great averages by comparing them year by year with typical establishments and by ascertaining the relative conditions of different parts of the country wherein the same branch of industry may be undertaken. To illustrate, there is one cotton factory in New England which has been operated for more than fifty years upon the same fabric, working the same grade of cotton, under the same conditions except so far as those conditions have been changed year by year in the progress of discovery and invention. That corporation has never failed, has rarely, if ever,

reduced its product, has been continuously profitable, and may therefore be taken as a typical establishment working on that standard grade of goods. From the books of that concern it is proved conclusively that in the course of fifty years it has been necessary to change the entire machinery of the factory, even though it might not have been worn out, two to four times according to its kind; second, there is but a part of the outer walls left and one or two floors of the original building; third, the whole motive power has been changed; fourth, the average capacity of each operative in the factory has been increased in productive power from five thousand yards per year produced in thirteen to fourteen hours per day, to thirty thousand yards per year produced in ten hours per day. The earnings of those who now work in that factory ten hours are nearly twice as much per day as the earnings of those who worked on the lesser product thirteen hours each day under the former conditions, and are more than double per hour, while the price of the cloth on the same cost of cotton is very much less to the consumer now than it was then. By that single typical standard the progress of that branch of textile manufacture may be measured more accurately than by any possible compilations of figures covering the whole country, however correctly they may be averaged.

The same rule of lower prices to consumers, higher wages to the workmen and less arduous conditions to the latter may be traced by following the history of any and every specific art which is of considerable importance. Now, if a permanent Census Bureau were established, all the principal arts and industries of the country could be thus traced out almost from their inception down to the present day by following the history of typical establishments. By this means the work of the quinquennial or decennial Census could be checked off, errors and false deductions could be avoided and the natural history of industry, if I may use the term, would be fully disclosed.

On the other hand, if it were deemed suitable to incorporate with this Department a similar line of investigation in respect to typical branches of industry in agriculture, manufactures and mining in other countries—especially among the machine-using nations, Great Britain, France, Germany, Belgium and Italy—the relative progress of the people of different countries as compared with this country would be conclusively and conspicuously brought out.

One may therefore most heartily sustain and approve every effort that can be made to establish a permanent Census Bureau, co-operating with the National and State Bureaus of Labor Statistics, to the end that the true progress of this country, which is even greater than the delusive figures would lead us to believe, may be made manifest to every one—that true progress consisting in the following results of the application of science and invention to the useful arts :

I. In agriculture, larger crops derived with less effort from lessening areas of land, whenever and wherever the land is treated as a laboratory to be worked with intelligence rather than as a mine which may be exhausted by unintelligent methods.

II. In respect to manufactures, an increasing value of more effective capital, accompanied by a tendency of profits to a minimum, as the joint product of capital and labor increases in its aggregate.

III. In proportion to the increase of capital, while the absolute share falling to the capitalist may be augmented, the relative share of the capitalist is diminished ; yet, according to the rule propounded by both Carey and Bastiat, the share falling to the workman is augmented both absolutely and relatively ; the end being that in each decade the true conditions of welfare, measured by subsistence, shelter and clothing, and not by the dollars of accumulated property or by the valuation of land, prove that with the progress of invention and the application of science, the workman secures to his own use and enjoyment an increasing proportion or share of a continuously-increasing product.

To the development of these facts of life and to the proof that such are the conditions, or to the disproof of such of these assertions as may not be facts, the work of a permanent Census Bureau would directly tend, because under the free conditions of society and the free commerce which prevails among the people of this country such are the necessary results of intelligence when applied to productive industry.

The question having been asked whether or not the enumeration should be made and the count of the Census be computed oftener than once in ten years, my opinion is that once in ten years is often enough for a national count and for the compilation of the figures customarily taken under Census Acts, but that it would be very desirable, and it would probably ensue from the establishment of a permanent national Census Bureau, that the several States

should each take an intermediate census guided by the forms which may be adopted by the national Census Bureau, to the end that through comparison of the figures secured by State action, the decennial Census of the nation may be sustained.

To my mind the most necessary Department yet remaining to be set at work in its full measure of usefulness, is a Department of Relative Statistics, by which the relative conditions of the different States of this Union, and of this Union as compared to other countries, may be brought into view. In the investigation of prices which is now going on, it will be clearly proved, if regard be given to the great staples or necessaries of life, that during the last fifty years (with the probable exception of the products of the forest which are becoming relatively scarce) there has been a continuous reduction in the prices of food, fuel, fibres and fabrics of all kinds, both in this and all other countries in which science and invention have been applied through the adoption and improvement of machinery to production and distribution.

That information will be of great value but the important point having regard to legislation is, to know how far the relative reduction in the cost and in the price of all these articles has corresponded in this and other countries. The relative statistics of prices year by year would have the greatest possible value in elucidating the currency and the tariff questions. The mere fact that prices are now lower than they used to be under different conditions is of very little importance unless we have this standard of relative prices in other countries under other conditions of currency and taxation, to which we may compare them year by year for a term of years. I should therefore expect one of the first developments of a permanent Census Bureau to be the establishment of *a science of the comparative statistics of nations*, than which nothing could be more important as a basis for intelligent legislation.

"FULTON NIGHT" WITH THE ENGINEERS.

By J. F. Holloway, M. E.,

Past President Am. Soc. Mechanical Engineers.

OF the three or four engineering societies of national importance with headquarters in New York, which by their meetings, discussions and published transactions have done so much not only to spread abroad engineering knowledge, but as well to bring into prominence the benefits conferred by their guild upon the world at large, none ranks higher in rapid growth and widespread influence than does The American Society of Mechanical Engineers. Having secured a building in which a handsomely-furnished parlor, a well-equipped library, pleasant reading rooms, snug offices, together with well-arranged audience and banqueting rooms are all combined, the Society is not only admirably equipped for carrying on the purposes of the organization, so far as its scientific pursuits are concerned, but also to afford its members and their friends facilities for social and fraternal gatherings too often overlooked in this busy, work-a-day world.

Advantage has been taken of these facilities for holding monthly reunions, to which the families of members as well as invited guests are admitted. On such occasions some topic of local engineering interest is made the nucleus around which is woven the papers read and the discussions which follow; these, interspersed with music, lantern-slide pictures projected on the screen, followed by a light lunch, have made many an evening in the past most enjoyable to all present. Among the recent gatherings of this class was one called "The Fulton Night," the occurrence of which was brought about by the presentation to the Society by one of its leading members of an elegant old Colonial mahogany dining table, once the property of Robert Fulton, and which by direct succession had come down to the donor. As may well be imagined the presence of that table, once the property of one of America's most noted engineers, together with other rare and interesting relics loaned for the occasion, could not fail to inspire some of the old-time naval and other engineers present into recitals of their experiences, adventures, and trials during the early days of steamboating on the Hudson River and the Sound; and if what they then said could have been collated and published it would have made an

interesting contribution to the history of steam engineering. As a reminiscence of the life of the former owner of the table, and as a fanciful retrospective of the changed times to which the old table that stood before them had come, the words which follow were spoken by an ex-president of the Society.—EDITOR.

IT has been wisely left to others to tell in detail the story of Fulton's life and achievements, and the little left me to say will be but in part biographical. Robert Fulton, as you have been told, was born in a farm-house in that garden of Pennsylvania, Lancaster county, in 1765. In the same neighborhood was the home also of one who in after years was his firm friend and at the same time America's most famous painter—Benjamin West. It was no doubt from roaming over the Conawango hills and beside the flowing waters of the romantic Conestoga that both West and Fulton imbibed that love for their native land they never sought to disguise, and that love of the beautiful in nature that became so pronounced in their after lives.

It was said of the boy Robert Fulton that he was what might be called a dull scholar, and once when chided by his teacher for his inattention to his studies he replied that his head was so full of original notions that there was no vacant place to store away the contents of dusty books.

One of the neighbors of his father, one Denter Grumpp, was very fond of fishing, and he had built for this purpose a flat-bottomed boat or scow, and he used to avail himself of the labors of his son Christopher and his neighbor's son Robert to aid him in his pursuit, by getting them to pole the boat over the waters of the Conestoga, while he fish-poled the perch and the bass into the boat. As well may be imagined this was not much amusement for the boys, but one of them put on his thinking cap as he pushed his way along, and, as usual, pushing and thinking won in the end.

Tiring of pole-pushing, Robert Fulton concluded that he would go over the hills and make his aunt a visit of a week or so, and it was in the garret of this aunt's house that he built a small model of Denter Grumpp's flat-boat, to which he planned and arranged a pair of paddle-wheels on a cross shaft, having on it hand-cranks. Coming back home, he confided to his chum Christopher his invention and, securing his aid, they together rigged up a paddle-shaft with wheels and cranks for the flat-boat of the elder Grumpp.

This was so arranged that the whole machinery could be lifted off and taken to a place of safety while not in use.

It was not long before the elder Grumpp had, as many another since has had, a longing to try his luck again on the waters of the Conestoga, and he summoned the before-time reluctant boys to help him out. What his surprise was, we perhaps can imagine, as he looked back from the boat and saw the two boys struggling down the river bank with a queer-looking conglomeration of iron and wood in the shape of cranks and wheels, on their shoulders, and just how the boys chuckled together as they saw the surprise in the staid old Dutchman's face we can also imagine. However, after suppressed giggling, they hung the shaft in its place, and the wheels over the side, taking their places at the cranks, and then and there started the first paddle-wheel boat ever seen in the new continent of America.

Later on Fulton became quite a miniature painter and at the age of seventeen he had saved enough money to buy for his widowed mother and his sister a farm in Northumberland county, where they spent the balance of their lives. A few years afterward he went abroad, where he met his old friend Benjamin West, who then had become a famous painter of landscapes and historical pieces, and who from his widely-known fame and connections, was able to be of much service to his Lancaster-county friend.

Will you allow me for a moment to digress from the consideration of Fulton to say a word about the boyhood of West? He too was a Lancaster-county boy, and his early life spent amid the hills and valleys of that favored spot stood him in good service when, in after life, he painted some of the landscape pictures that helped to make him famous. He early showed not only a taste but an aptness for drawing, and with the only utensils at his command, a gray goose-quill pen, and black and red ink, he, without the aid of a teacher, began his life's work. One day a party of Indians came into the village and he showed them his pictures thus drawn, of birds and flowers, and so pleased were the red men that they gave him some of the colors with which they painted their ornaments. With these rude pigments, and a pencil made of the hairs from the family cat, fastened in the small end of a goose-quill, Benjamin West painted his first picture of colors; and looking at it sixty years afterwards he said it had in it some touches of art he had never since excelled. But the eventful period of his life came at the time when he became sixteen years old. We can fancy that the staid old

Quakers of that day, of which his father and mother were no doubt shining examples, had little encouragement to give a boy who, as it seemed to them, was thus widely drifting away from the example and faith of his fathers; so a meeting of Friends was called to consider his case. You can perhaps fancy the feelings of the boy, with all his dreams of imagination luring him onward, standing alone in the midst of that solemn silence; and you have not known what solemn silence is if you have never sat in the plain, neat meeting-house of the Friends, in some rural district. After a long communion in silence, in which their earnest, honest hearts pleaded to Heaven for guidance, John Williamson, moved by the spirit, rose up to speak. What he said on that occasion can only be imagined, it will never be known; but we are led to believe that he pleaded for the boy, and for the God-given genius and inspiration that was within him, for, as he took his seat, a sweet-faced mother in Israel rose from her seat and walking calmly across the room came to the side of the down-cast boy and imparted on his fair cheek a mother's kiss; then other mothers, and maidens, without one spoken word, following her example, kissed him and turned away as if they were, by so doing, offering him up as a sacrifice to an untimely fate, rather than as an offering to a vocation that afterwards filled the world with his praise, and all nations with admiration of his genius. If it were permitted to any of that group of sorrowing hearts, in after years, to gaze upon his sublime paintings of the "Crucifixion" or the "Descent from the Cross," how thankful they must have been that on that eventful day, in the old meeting-house among the hills, they consecrated the boy Benjamin West to his divine art.

You will by this time be inclined to distrust the announcement made that I would give you "table talk," and you will be saying that if it takes all this time to reach the "dining table" of Fulton you are glad I do not have all his household treasures to talk about.

It may well be said of engineers that "while we exist by our occupation, we live in our imagination," and I for one am glad it is so, for I must make a heavy draft on your imagination to-night. Before you stands the old solid mahogany Colonial dining table, once the property of Robert Fulton and which, through the successive generations of the Egleston family, has by the kindness of our honored member, Professor Thomas Egleston, found at last a resting place in the house of The American Society of Mechanical Engineers, and in no other place could it be as highly prized.

Now I have told you all I know about the table; the rest you must imagine.

Turn your thoughts for a few moments backward to the beginning of the present century; think, if you can, how different everything then was from now; think of the innumerable blessings which, thanks to the skill and genius of the engineer, you now enjoy, and which would be blotted out could the hands on the dial of time be turned backwards, not as at the command of a Joshua for a whole day, but for seventy-five years.

It may truly be said of Robert Fulton that he not only had all the requirements of the courtly gentleman of his day, but he had within him the elements that would have stamped him a gentleman in all times and under all circumstances. As the warm friend of that other Lancaster-county boy, of whom I spoke, and who, in after life, took the place left vacant by the death of Sir Joshua Reynolds, the presidency of the Royal Academy, and whose remains were honored with a resting place in St. Paul's churchyard —Benjamin West—he had many opportunities to make the acquaintance of and to associate with many of the famous men of his time both in England and France, and it will require no great stretch of your imagination to believe that in after years, when he had returned to bless his native land by his genius and his skill, some of these old-world friends, coming to this then new one, found hospitable cheer and a warm welcome around that well-kept table.

But there were many and varied groups that must have gathered there in gone-by days; some sad, some joyous.

We engineers who in late years, with all the resources of good tools and variety of material at our command, have made sad and lamentable failures, can well imagine what must have been the trials and difficulties under which Robert Fulton struggled when he first sought to solve the problem of steam-driven boats on river and sea. What would our friend here, Andrew Fletcher, whose swift-moving steamers have since proudly tossed from their bow, at the rate of twenty miles an hour, the same waters through which Fulton's *Clermont* struggled at the rate of five miles, have thought, if he had been shown a board pile and had been asked to make out of it a steamboat boiler, as Fulton had to do? I dare say our friend well remembers when the widest sheet of boiler plate that could be procured was but 26 inches; but 3-16 inch iron plates 26 inches wide were far better stock from which to make boilers than

wooden staves bound together by bands of iron, as were those on Fulton's first boat.

No doubt engineers in the old times, as now, were wont to take to the home circle the cares and vexations of their business, and no doubt there were days when, after a night of restless tossing, trying in some way to scheme out a remedy for some new and unexpected difficulties, our hero sat him down to that table, his usual genial good humor gone, and with few words for wife and children, and leaving his scarce-tasted food, he walked out, as has many another, to take up anew the battle of life.

But let us put that picture aside. Look at the old table now; it is set for a grand supper; its broad surface is loaded with the old-time elements that go to make up a feast, for in that good old time a banquet table had on it much beside a bunch of flowers and a few empty plates. See the quaintly-dressed neighbors who come crowding in to take their place at the table, and to honor their friend and host whose newly-built steam-moved boat has just made the round trip to Albany and back inside of four days, and as they shake the hand of the master and congratulate him on his great success, they little dream of the grand future of which that day's performance was but the beginning.

We fancy as we look at them, dressed in knickerbockers and with silver buckles on their shoes, and powder on their hair, and the quaint cues hanging down their backs, and see the bloom of manly health on their cheeks and the merry twinkle of their eyes, that they must be a merry set; and while possibly they did have their cares and anxieties, they were not concerning the effects of the McKinley Bill, or the free coinage of silver—but listen: One rises to propose the good health of the man who had invented and built the first boat that, with steam-turned paddle-wheels, had bid defiance to wind and tides, and which unaided by mast and sail, could move forward on any waters. To tell you, as the old table could, of the merry clinking of the glasses and the wild "Hip, hip, hurrah!" that followed, would be to tell you what you yourselves know full well. But listen again: The genial host rises to respond. Thanking them for all their good wishes, in modest tones he is telling them something of the trials and disappointments he had encountered in the past; and that harder than all else to bear, had been the cruel jeers of those whom once he had counted among his friends but who, seeing his persistency in his purpose, had turned from him with bitter words. He is telling his guests that, impelled

by a belief that he would at last succeed, he could not turn back, but now that the hour of his triumph had come, he had only the kindliest feelings toward all. He tells them that beyond the present he sees the time coming in which not only the waters of the noble Hudson, but those of the beautiful Ohio and the mighty Mississippi, as well, would be dotted over with steamboats carrying to and fro the wealth and products of an immense empire, and that on the ocean the steamship would bear messages of peace and good-will to all lands, and that long after they had all passed away, thanks to the labors of the coming Engineers, the white flag of a peaceful commerce would cement in a bond of one common welfare, all the nations of the earth.

GEOLOGY FROM A BUSINESS POINT OF VIEW.

By Edward H. Williams, Jr., M. E.

AMERICANS pride themselves upon being "practical." Their energy and audacity are developed in professional and business ventures at an earlier age than obtains abroad. Not satisfied with the period at which they began work, or the training they underwent, they are seeking to anticipate the former by weeding from the college curriculum "all the 'isms' and 'ologies,'" and, among them, Geology. It is not denied that some subjects are antiquated; nor would it be wrong to adapt the course of study to the needs of the age; but everything that tends to broaden the mind and stimulate rapid and exact observation must be retained; in other words the natural sciences and their keystone, Geology, must remain, because there is money in the same. The present issue of this magazine could easily be filled with essays on the developments of Geology in mining, metallurgy, ore-dressing, sanitary science, agriculture, and kindred matters that appeal more or less directly to the pocket of the individual, and, therefore, in the limits of this article, but a brief mention can be made of some of the important sides of the question.

Geology is valuable in two ways. It develops the mind; imparts to its students habits of rapid and accurate observation, and shows them how and where to make money and how to keep it when made. In other words, it makes a quick and accurate man, and it tells him when to invest and when to keep out of the "deal." If these are not business traits of the highest types there has been a decided change in trade of late. Under the first head Geology meets us as scholars. If there obtains a wrong opinion of the subject in the mind of any one, lay it to the fault of the teacher rather than the poverty of the study. The best teachers go to the fountain-head of any subject, and the best geological teachers let Nature tell her own story in her own way, and do not attempt to compress the power that fashioned and maintains the world within the compass of a "fourteen weeks' course." The travesty of Geology that takes its place in many institutions must bear the blame for the opinion universally held by the masses. To them it is a dead subject—as dead as Sanskrit, and as valueless for practical purposes—instead of being replete with vitality that is communica-

ted to the student and makes him a thinker and worker. It is unnecessary to develop this point, and show that a "natural science" is best calculated to attract the attention and develop the above traits. Nor is it necessary to do more than state that children are born with habits of acquiring and hoarding. The boys come home with their pockets swelled with strange and beautiful things. The only point required by the collector is that the thing is easily movable, and it goes to swell the miscellaneous gathering that is generally, I am sorry to say, swept into the dust-hole by the orderly mother. The habit dies hard under a prohibitory tariff of penalties, so that the youngster loses his habits of observation as he ceases to be a collector, and degenerates into a man who has no perception for—

"Books in the running brooks,
Sermons in stones,
And good in everything."

There is no need of breeding a race that will go through life with blind and heedless eyes, and it is criminal to stunt the powers and curtail the sphere of activity of our children. If they become of limited capacities as men, and call Geology and its congeners nonsense, the fault lies at our doors. If they fail at the decisive moment from an inability to see what is plainly before them, the blame is on our shoulders, as we have repressed their childish desires to acquire knowledge. Geology is a cheap study. There is no capital required for a preliminary investment; but the book is open "so that he who runs may read," and is most widely open to the country boy. As, however, the most successful business men have been proved to be from the country, it follows that the book is open to their study in the highest degree. Let this appeal go to the fathers and mothers of to-day, that they may see in the bits of broken glass; the rounded pebbles, and the thousand-and-one odd things that appeal to the eye of the youngsters, the most efficient aids in their education. Teach the collector to distinguish between the most, the more, and the less useful; to compare similar and dissimilar things; to arrange, classify, and find the "how?" and the "why?" of each form, so that they can be recognized when next met, and we need not fear for the future. Nature will open her book to them, and they will find there no end to the lessons to be learned, and no weariness in learning. The growth in bodily stature will be paralleled by an increase in mental vigor and quickness of perception. Anything strange will be at once seen and

questioned. An identity or a similarity will appeal to them as does the finger-post to the traveller, and they will accept at par value what Nature holds forth with unstinted hand. Even if the later life be passed in trade, the quickness of perception and the range of thought thus acquired will insure a more perfect command of the business ; a greater readiness to detect fluctuations and prepare for them, and thus a greater power to make and keep money.

In the second place, Geology is not all "ism." We invest in mines, quarries, oil-wells, farms, and other developments of the earth's crust. Geology is the science of that crust and all that it contains. Economic Geology treats of what is marketable therein. Here is something that appeals directly to dollars and cents, because it tells us where valuable things are to be found ; where they are not to be found (which is of the highest importance), and under what conditions they will be found. The writer was told in 1883 by one of our most successful mining engineers, then superintendent of a newly-organized coal company, that he was having a hard time with the president, as that worthy knew nothing of Geology or coal, and could not see why it was necessary to go to farther expense than to lay a track alongside of the coal outcrop, buy a lot of shovels, hire the necessary labor, and shovel the coal upon the cars. This man was not, is not, and will not be the only one who has invested in, and assumed direction of an industry of which he knew nothing ; but it is safe to affirm that the great majority of the cases will be connected with Economic Geology. The public is better acquainted with Geology as shown in the extensive reports of State surveys, or in fights over points that will have no effect on the money market, and pays little attention to the stories of the easily-made fortunes of quick observers. If such stories are read they generally breed a belief that all mining operations are equally successful, and this brings about the dark side of the picture—that as much money is generally lost in every mining camp by those who invest with blind eyes, as is gained by those who can see. A practical knowledge of Geology is of considerable value, therefore, and we can use it as an amusement or a profession. As the tramps are our only "gentlemen of leisure," the nobility may be restricted to the Geological Tramps. They are not only unconfined to time or locality ; but their knowledge gives them a certain power over natural forces, and makes them favorites of fortune, as they can sift the valuable from the ornamental displays that surround them. A walk over the mountain to Friedensville, Pa., one spring day

when the farmers were plowing their fields, brought the late Dr. Roepper, well known to mineralogists, to where a team was dragging a plow near the road. A talk with the driver brought out the fact that his farm was cursed with more than the usual amount of stones, and a sample was tossed over the fence to the doctor, as evidence. It was recognized as a mass of quartz carrying calamine —a silicate of zinc. The fence was climbed and the two followed the plow forward and back across a field covered with similar masses. Had the doctor been a Yankee he would have bought the farm and died a rich man. As he was only an honest lover of Nature he said a few words to the plowman that transformed an exhausted Pennsylvania farm into the seat of the Ueberroth mine; that set in operation the extensive zinc works of Bethlehem, Pa., and built the "President"—a pump that could raise 17,000 gallons of water per minute. This chance shot at a fortune is but one of many, and a dozen volumes would ill-suffice to note the salient points of the record. If so much can be done haphazard, it is evident that a systematic training in Economic Geology will furnish a means for a livelihood, as well as an aid in the consideration of economic questions in mining.

From this branch of the subject the student finds that there are building-stones, roofing and fictile materials, heat-producers, mortars and cements, fertilizers, and other economic products besides ores and metals in the earth. He further learns that, as the stars differ in glory, so these vary in value, and he ascertains why a certain sandstone is and ever will be unfit for use, and a certain ore will never be worth mining under present conditions. He will, therefore, not invest in either. He is taught to associate certain formations with the chance of finding a series of valuable products. These all lead to money-making. For example, brine springs have led to the development of large beds of rock salt. The thin films of "Seneca oil" on the springs of Western New York and Pennsylvania were carefully skimmed from the surface, bottled and sold for rheumatism for years. The right pair of eyes saw in those iridescent films the extensive deposits of petroleum. California Gulch, Col., was a worn-out placer-mining town when a man we shall call Jones drifted there. Thousands of dollars had been found and about as much lost; a rough town had sprung up like a mushroom, and like it had disappeared with the exhaustion of the deposit, so that Jones came to a dying town and a worn-out camp. The remaining miners worked in a listless manner at claims that

had been exhausted and abandoned and, whether they made money or not, they all expressed a decided opinion about the "dry bone," as they called a heavy white rock that clogged the riffles of their sluices, and had to be removed by hand as it was too heavy for water to move. Jones had not been in luck, or he never would have come to such a place; but he had a slight knowledge of mineralogy and the use of the blow-pipe. He recognized the "dry bone" as carbonate of lead, and his blow-pipe showed him that it was carrying silver in good amount. From that time he prospected for its outcrop, though he pretended to hunt for gold. When discovered on some out-of-the-way corner of the camp he would be trying to find a "color" in dirt of no value, and soon secured the reputation of a fool and the compassion of the more experienced. At length the origin of the ore was found, and a Chicago capitalist supplied the money to locate and work the claims. After waiting for years, until the owners of the necessary pieces of ground had decided that there was no use in hunting longer for gold, and had abandoned them for Jones to stake out, the world was quietly informed that the much-anathematized "dry bone" was one of the richest silver ores of the world and, in a day, the butt of endless jokes was lauded to the skies as a wise man and a probable millionaire, and California Gulch, the worn-out gold digging, leaped into vigorous life as Leadville. This is but one of many instances where the glance of an experienced eye found the fortune that Nature had been holding out to the gaze of blind men for ages.

On the other hand the number of cases is increasing where geological knowledge has been used to predict the existence of deposits in certain places and to find them. In this respect the mining engineer is far above the ordinary prospector who stumbles upon a fortune in his wanderings. Geology shows us that an identity of conditions produces an identity of results. The forces in operation are few in number, and their workings are constantly repeated with but slight variations. A crack in the earth's crust from a strained condition is generally accompanied by others parallel to it, and the filling of these (which we call veins) is generally of the same material. If we are working a paying vein it will be worth our time to see if others are not lying parallel to it. Again, sedimentary beds were laid under water and conformable to the shape of the bottom, or to a plane nearly horizontal. They were afterwards bent and twisted. Suppose we find a paying bed of coal dipping under our feet and disappearing. We know that it will come

up again—unless a fault occurs—and it will pay us to find where it re-appears.

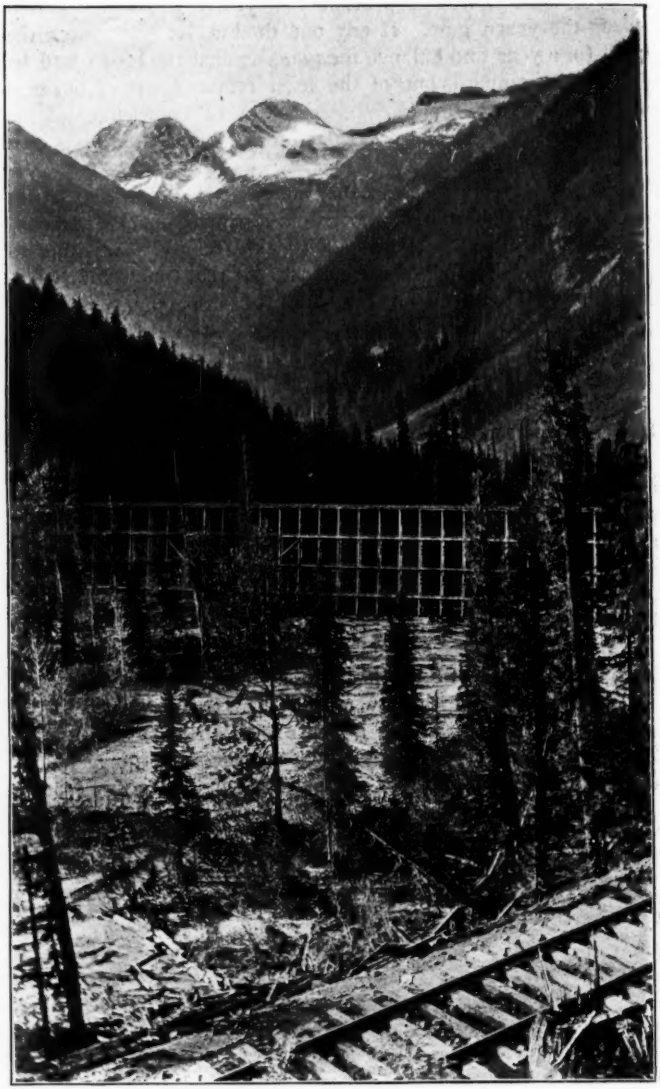
Every student of Callon's "Lectures on Mining" remembers the interesting story of the finding of the coal mines in the departments of the Nord and the Pas-de-Calais. They were unknown 150 years ago, though the mines near the French frontier in Belgium were already worked. As they approached the frontier, the measures dipped under barren rock; but they were followed by the trained eyes of French engineers and found near Valenciennes and Douai. In the same way the extension of the great Sarrebruck field was found in France, only to be lost in the Franco-Prussian War. The Calumet and Hecla copper mine, that controls the world's market, was the result of engineering skill in applying geological knowledge. The Comstock Lode had a strip of barren ground that had lain untouched while those adjoining had been worked to advantage. A pair of experienced eyes saw indications of value; the strip was secured and the great Bonanza gave its hundreds of millions of dollars to the right persons. Certain prospectors thought they could find in Wisconsin the extension of the extensive iron deposits of the upper Michigan peninsula. They were found at the place sought, and the Gogebic mining region, with the towns of Hurley and Bessemer, are the monuments to mark the value of the work done.

The business man is more frequently an investor in than a developer of mining properties. He depends almost entirely on the report of another and, even if he goes to the spot, he can see nothing for himself but must look through the eyes of another. The writer has had numbers of letters from business men asking what they should do when they went to their mine; what they should look at, what they should expect. In other words, they had invested in what they knew little or nothing about. If the investment had been in the ordinary branches of trade, they would have weighed all the chances before they would have placed a dollar; but they rush blindly into mining and expect to get back their investment the first year. It is on this account that we hear of "wild-cat" mining. There are plenty of people waiting to be fleeced, and there are those who know it and are ready to accommodate them. The adage of the "singed cat" does not hold with this class, as they no sooner lose than they rush deeper into the fire in the hope of recovering what has irretrievably gone. Certainly a knowledge of the manner in which ores and metals occur must be

called valuable if it will prevent this yearly loss—a loss that exceeds the yearly gain. If any one doubts, let him search the papers for a year and balance the gains against the losses, and he will find that mining is one of the least remunerative of business ventures, owing to the foolishness (want of knowledge) of the average investor. Geology is therefore a matter of dollars and cents in this respect.

There is more in Geology than mining. The old-time settler built a house and barn with privies and manure-heaps located conveniently to the well. If he had a sickly family it was due to "malaria," or some other obscure cause. At that time sanitary science had not joined hand with the editors of our popular periodicals, and nothing was said. To-day is a long way from the yesterday of such ignorance, and yet we find communities locating graveyards and digging sink-holes over their water supplies. When an epidemic occurs it is charged against a mysterious Providence in a vague way, instead of being laid at the doors of the barbarians who invented the system and the criminals who maintain it. A small amount of geological knowledge will show that there are many kinds of springs, and while some will be contaminated only at their source, others may be fouled at any point. Here is an instance where the ounce of geological prevention is worth all the money of the world, as it is impossible to recall a life once lost by filthy sanitary habits.

In the same way the subject may be extended to other points that touch the health or the pockets of the masses; but enough has been said to show that we must leave Geology in the list of studies at all hazards, as there is not one of them that will do as much for education. Geology is the mother of Mining. Watt's first steam-pump was built for a mine. The first tramway carried mining produce, and the first locomotive ran on a mine road. Civil and Mechanical Engineering are thus the children of Mining and the grandchildren of Geology, and the trade of the world is the growth of this parent trunk.



THE LOOP, CANADIAN PACIFIC RAILWAY.

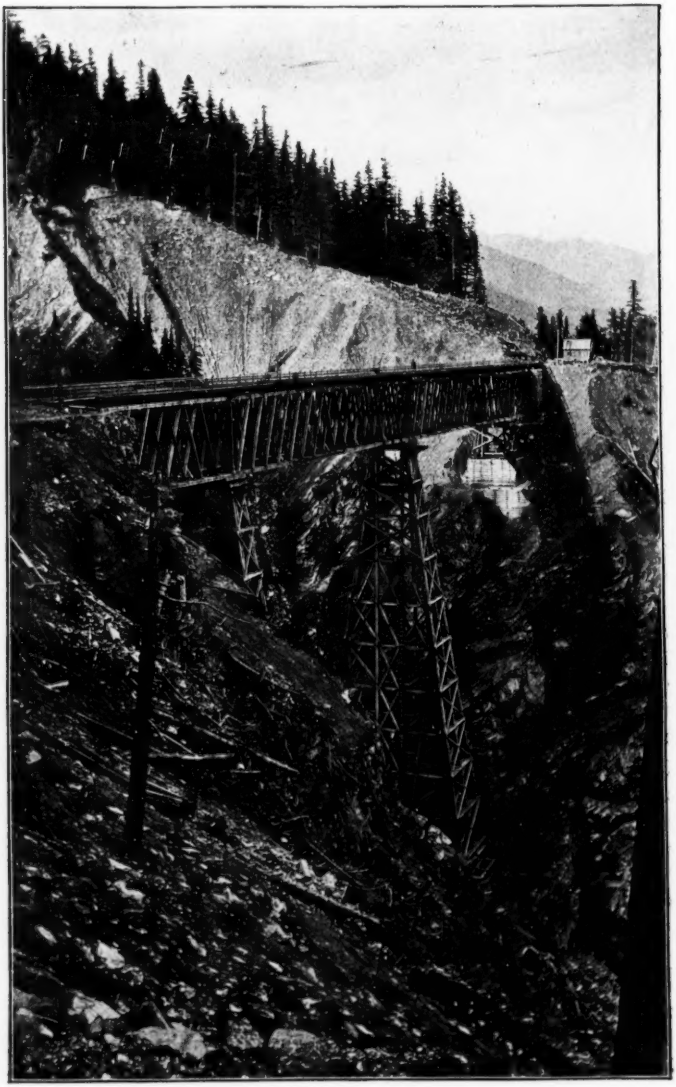
THE CANADIAN PACIFIC RAILWAY.

By T. Kennard Thomson, Asso. Mem. Am. Soc. C. E.

WHEN Jacques Cartier discovered the St. Lawrence River in 1535 and heard the Indians speak of their villages as Kannatha he thought they were referring to the country at large and recorded the name Canada for the first time. It was not, however, until 1608 that France took formal possession of Quebec and from that fort ruled over the country then called Canada, extending from Nova Scotia to Lake Superior and then down the Mississippi valley to the Gulf. In 1759 General Wolfe defeated the French at Quebec and four years later France formally renounced all her rights in Canada to England. The conquered people were allowed to retain their own language, laws and religion and soon the country was divided into Upper and Lower Canada, or Ontario and Quebec, and the latter has remained to this day almost entirely French, having almost no intercourse with English-speaking provinces.

In 1867, on the 1st of July—now called "Dominion Day"—Ontario, Quebec, Nova Scotia and New Brunswick were united as the Dominion of Canada. The two maritime provinces were induced to take this step by the federal government agreeing to build the proposed military railroad—the International—from Halifax to Quebec. This road was completed in 1876. In 1869 the Dominion, having acquired that vast region lying north of the United States boundary line and between Lake Superior and the Rocky Mountains, from the Hudson Bay Company, for about $1,000,000, turned the old "Red River Settlement" into the Province of Manitoba and divided the rest into the Northwest Territories. Two years later British Columbia was persuaded to join the union, the bait being a railroad from the Pacific to the Atlantic to be completed within ten years. Thus the Dominion was pledged to the stupendous task of constructing the Canadian Pacific Railway and was kept up to the mark by British Columbia and the young but vigorous Manitoba continually threatening to knock at our doors for admission if the project were allowed to lag or fall through.

The Canadian Parliament of 1872 endeavored to have the road built and operated by a private corporation subsidized by the Gov-



STONY CREEK BRIDGE, SELKIRKS, B. C.

ernment and entered into a contract with the late Sir Hugh Allan of the Allan Line of steamers, granting him a subsidy of $30,000,000 cash and 50,000,000 acres of land. This, however, greatly excited the older provinces and resulted in the "Pacific Scandal" which turned the conservative party out of power. The Reform government commenced the work of construction in 1875 at Lake Superior, prosecuting it as a public work. But when Sir John A. Macdonald returned to power he made a contract with the present company in 1880 on the basis of—

I. Twenty-five million dollars cash and 25,000,000 acres of selected lands in the fertile belt of the Northwest in addition to right of way on or through public property.

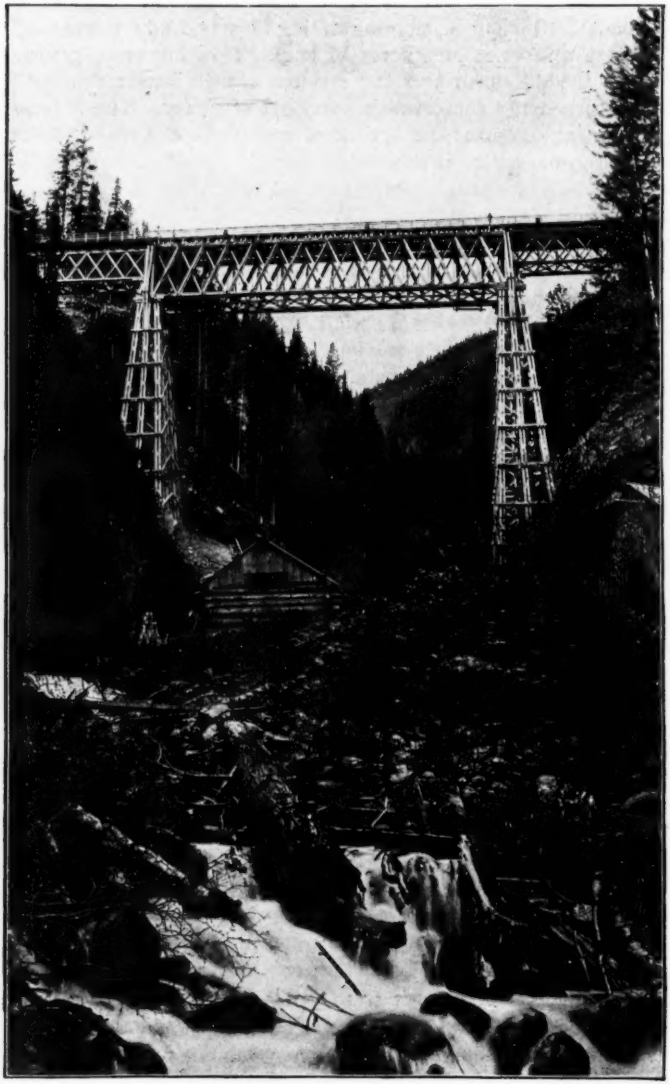
II. Free import for all materials of construction.

III. The government sections under construction at Lake Superior and in British Columbia to be completed, with the exception of rolling-stock, and to be handed over to the company as a free gift. This was done at a cost of $30,000,000.

IV. Freedom from taxation on all property used for the construction and working of the railway forever, and on the land grant for a period of twenty years unless sold or occupied.

V. No other line to be chartered for twenty years in the "Northwest" south of the Canadian Pacific Railway.

For the above considerations the company agreed to build and operate for ten years about 2000 miles of railroad. The capital stock was fixed at $100,000,000 and it was hoped to raise what might be required in addition by selling or mortgaging the lands. But as no one expected to see this a paying road, on account of the great expense of construction, and the fact that the government lands were given away to settlers, the Canadian Pacific Railway Company could raise no money on its land grants. So in the fall of 1883, when only $65,000,000 of stock had been sold, and all the proceeds used for the construction, the Canadian Pacific Railway endeavored to sell the balance of its stock by getting the government to guarantee a 6 per cent. dividend on its entire stock for a period of ten years, but, owing to the stringency of the money market at that time, this scheme availed nothing. The Dominion was then practically compelled to come to the rescue, to prevent the financial ruin and disintegration of its provinces, and advanced $22,500,000 for which the Canadian Pacific Railway gave a lien on its whole property and also agreed to complete its entire line by May 1, 1886, or five years in advance of its contract time. Con-



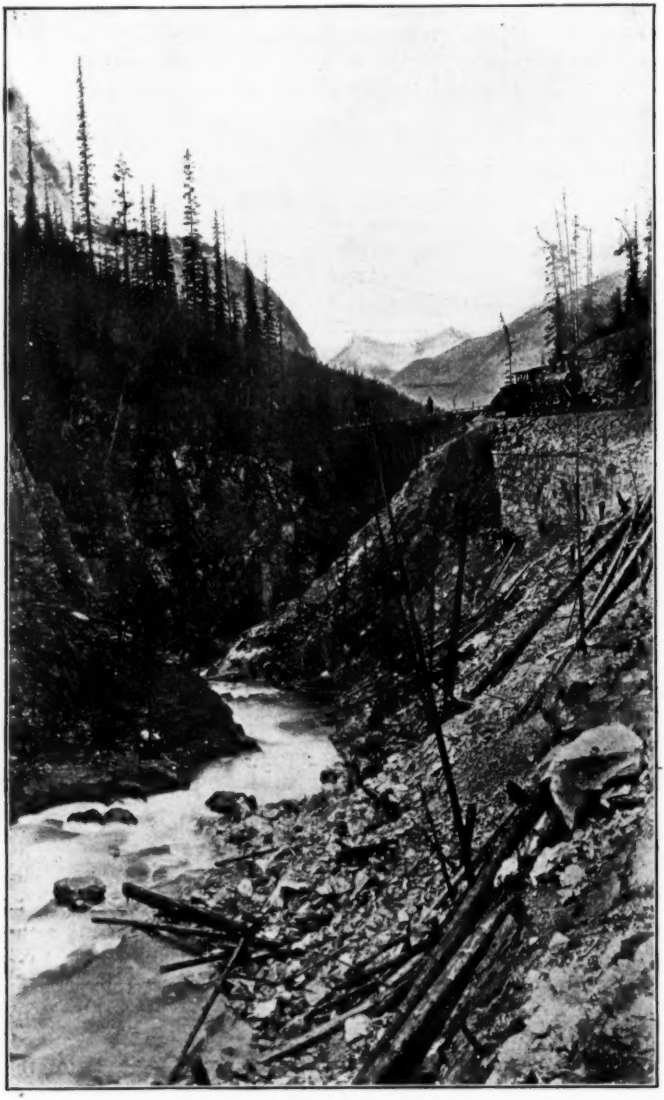
SURPRISE CREEK BRIDGE, SELKIRKS, B. C.

structing the railroad at the rate of 500 miles a year soon used up the last loan and the government lien made it utterly impossible to dispose of its remaining $35,000,000 of unsold stock, so the Dominion was forced to hand over another $30,000,000 cash for mortgage bonds.

All this time the Opposition, especially from the older provinces, was making it very unpleasant for the Government and it was predicted that this great railway would wreck half a dozen cabinets before it was completed and, but for that wonderful leader Sir John A. Macdonald, the Father of the Dominion, this prediction would probably have been fulfilled. Not until 1885 did the strenuous opposition of many of the Canadians to the Canadian Pacific Railway begin to slacken and then only on account of a catastrophe which startled the whole of Canada, and brought out strongly one of the many advantages that this railway would afford. It was the rebellion of the Indians and Metis (half-breed French and Indian), which broke out in the North Saskatchewan district, when it seemed impossible for aid to reach the scattered settlers. However, volunteers rushed to arms in Manitoba and the Eastern Provinces. By the difficulty which the volunteers experienced in reaching the scene of action all Canada was convinced that the Canadian Pacific Railway was a political and military necessity, if nothing else.

The track-laying was rushed on and by November, 1885, the railway was complete from Montreal to the Pacific Ocean. In the following spring the railway company, to the surprise of everybody, paid off its debt to the Government with $20,000,000 cash and 6,800,000 acres of land, the Government only retaining $1,000,000 of land-grant bonds to ensure the construction of a permanent line to replace a temporary line of nine miles in the Kicking Horse Pass. The Canadian Pacific Railway was then free from all debt and entering an era of unequalled prosperity.

The Province of Manitoba chartered some short lines from Winnipeg south, and as the Dominion Government was obliged to keep its contract with the Canadian Pacific Railway, and as the Manitobans threatened civil war if they were not allowed to have all the railroads they wanted, the Dominion guaranteed to pay the Canadian Pacific 3½ per cent. interest on $15,000,000 for fifty years to give up its privileges in this respect. Thus peace was restored While Canada had to pay a big price, about $85,000,000, for the Canadian Pacific, it was the only way that a trans-continental rail-



BIG GRADE, ROCKIES, B. C.

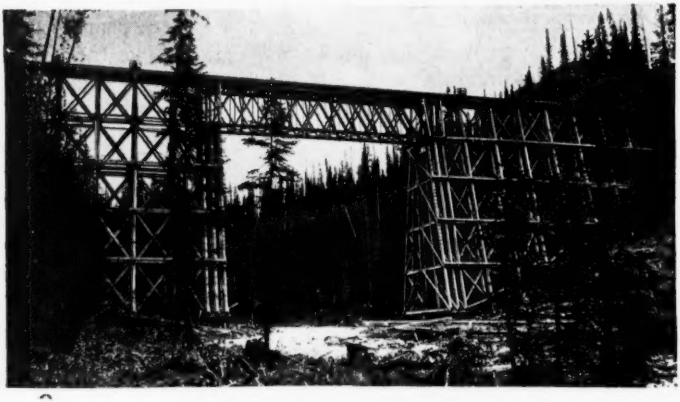
road could have been obtained. Had the Canadian Pacific Railway not been started the Federation would have broken up and British Columbia, Manitoba and probably Nova Scotia and New Brunswick would have knocked at our doors for admission, and had the construction been stopped after having been commenced, Canada would have experienced a commercial ruin seldom, if ever, equalled. Instead of which it is now firmly united by the greatest railroad in the world, and has opened up millions of acres of farming lands hitherto inaccessible. The two sections of the Canadian Pacific Railway which were built by the Government and handed over to the company as a free gift consisted of 213 miles from Port Moody —the Pacific terminus—costing on an average $80,000 per mile and 430 miles between Winnipeg and Lake Superior. The rock cuts, bridges, trestles and tunnels made this section also very expensive, and $750,000 was spent on a single mile.

When the Canadian Pacific was turned over to a private company in 1881 construction was started at Callander, Ontario, and at Winnipeg and pushed westward to meet the government lines—closing both gaps in the fall of 1885. Since then it has built or acquired lines or branches to nearly every important point in Canada, besides bridging the St. Lawrence at Montreal and building a short line to New Brunswick through Maine. It now talks of bridging the St. Lawrence from Prescott to Ogdensburg to connect with the New York Central ; of bridging the Niagara, of running into Chicago, and so on. The branch line from Sudbury to Sault Ste. Marie gives that city its shortest route to the Atlantic and taps North Dakota, Minnesota and Wisconsin. This enables the Canadian Pacific to snap its fingers at our lines as it did lately when it reduced the freight rate from Boston to St. Paul to 51 cents per 100 pounds, whereas the rate over our line from Boston to Chicago is 75 cents for the same class of goods. The main line, from Halifax to the Pacific, is now practically 3662 miles long. With the acquired lines and branches 7000 miles are embraced, and if, as now seems probable, it absorbs the Grand Trunk Railway, it will have over 10,000 miles under one management. Not content with controlling the railroad system of Canada the Canadian Pacific Railway has a magnificent line of steamers on Lake Superior and the Pacific Ocean, both of which compare favorably with the best Atlantic liners, and the latter has reduced the time between Yokohama and British Columbia to nine days and nineteen hours. A line of steamers will soon be placed on the St.

Lawrence River, and it will probably not be long before this company has its own Atlantic steamers which, by sailing from Halifax or Cape Breton, will have a route to Liverpool nearly 1000 miles shorter than from New York.

The Canadian Pacific owns, for the benefit of its common shareholders, its own telegraph and express lines, Pullman cars and restaurants. The Canadian Pacific Railway has already spent over $200,000,000 and spent them well. The net earnings for a single week in September, 1891, were nearly $450,000.

When we consider that this company was only organized in 1881



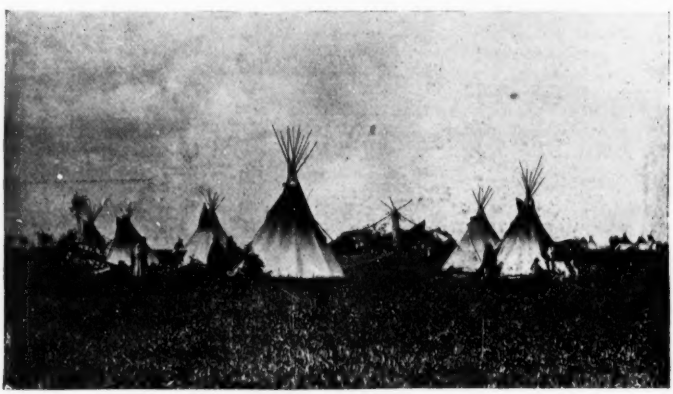
OTTER TAIL BRIDGE, CANADIAN PACIFIC RAILWAY.

—the Government had not built 300 miles at that time—and that for five years after it was considered a dead outlay and vigorously opposed, can we help admiring the ability of the three men who deserve the chief credit—Sir John A. Macdonald, who assisted the road to the utmost of his power in the interest of the autonomy of Canada, to which his life was devoted; Sir George Stephen, the first president, who so ably financiered the company, and the energetic W. C. Van Horne, first general manager and now president?

The construction of the Canadian Pacific in Ontario and Quebec presents no very interesting features. From Ottawa to Winnipeg, however, a wild undeveloped country was traversed at great expense. On this section the track crosses a bog, and every passing train causes the ties and rails to move forward from six to twelve inches, and the whole surface of the ground heaves and falls like ocean waves. From Winnipeg it was a question whether to run

FROM THE LOWER TUNNEL, ROCKIES, BRITISH COLUMBIA.

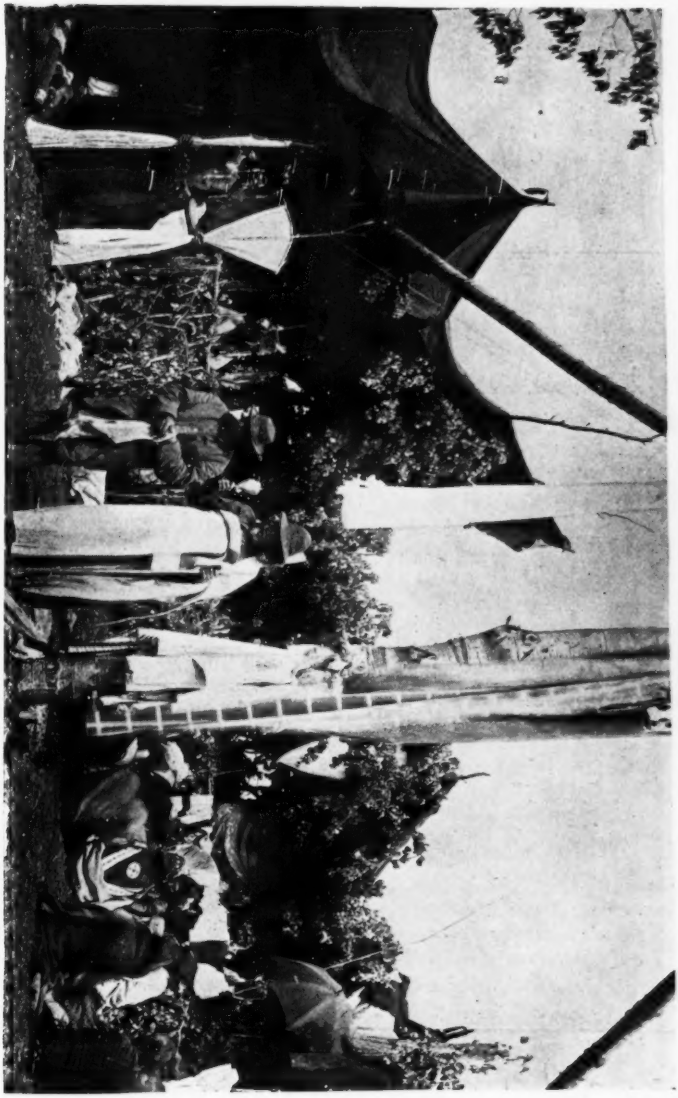
the line due west from Winnipeg, passing over the "Great Sandy Desert," or to follow the Red River north for 200 miles to the North Saskatchewan district, and then make straight for the Yellow Head Pass, the highest point of which is 3733 feet above the sea. No grade greater than 1 per cent. would have been required. The Government had decided to adopt the latter route as it passed through the most settled portion of the North West, contained all the timber lands and afforded the best mountain pass. But when the Canadian Pacific was formed as a private company it secured the permission of the Government to adopt the more direct and southern route. The prairies on the line of the Canadian Pacific are divided into three plateaus—the first from Winnipeg to Regina



CREE THIRST DANCE, EDMONTON, NORTHWEST TERRITORY.

contains the finest wheat land in the world, but produces no other crop; the second, from Regina to Medicine Hat averages about 1600 feet above the sea or 700 feet above the first. This is described on the old maps as a "great sandy desert," and though large experimental farms have been declared successful, the summer I spent there convinces me that the old Scotch farmer was not far wrong when he described his farm as being "fifty miles from water; 500 miles from fuel; 40 degrees below zero; God bless our home!"

On crossing the South Saskatchewan River at Medicine Hat the ascent to the third plateau is so steep that an additional engine is required to start the train. This is a magnificent grazing country and it is claimed that cattle can remain out all winter—though I



CREE THIRST DANCE, EDMONTON, NORTHWEST TERRITORY.

KANANASKIS FALLS, ROCKIES, NORTHWEST TERRITORY.

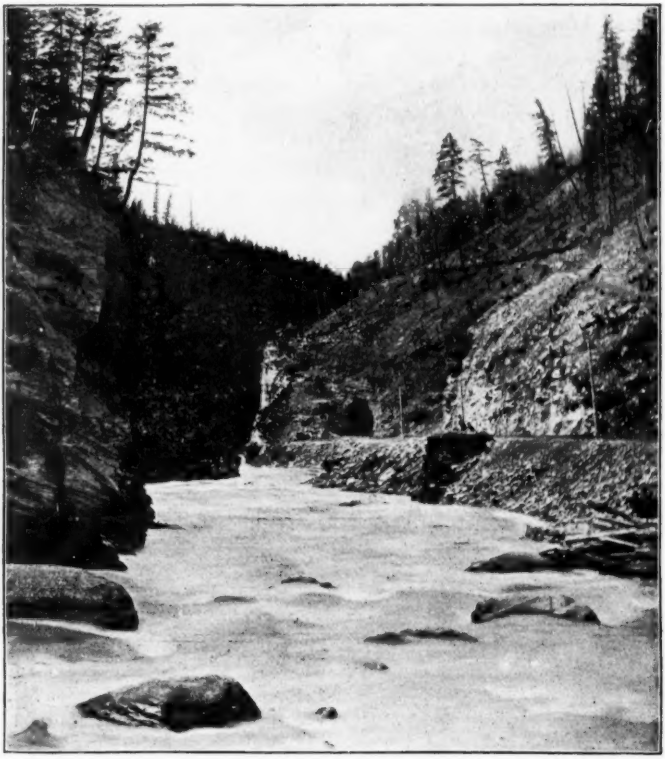
have broken an inch of ice in my waterpail in August, and seen the thermometer register 27 degrees below zero in November. On crossing the plains the policy was adopted of keeping the track on the highest ground possible, so as to avoid trouble with snow drifts, and to do this the crown of the hills or undulations of the prairies were followed, and numerous curves introduced. It might be remarked that the Canadian Pacific followed an old Indian trail nearly all the way across. On the third plateau some of the quickest railroading on record was done under Mr. James Ross, general manager of construction of that division, when he graded, built all the bridges and laid the track from Swift Current to the summit of the Rockies, about 400 miles, between March and November of 1883. The ties, rails and supplies of all kinds had to be brought over a thousand miles by rail.

From Calgary the Canadian Pacific follows the Bow River to the summit of the Pass through the Rocky Mountains, 5300 feet above the sea. The Bow and Kicking Horse rivers drain the same pond, the first eventually finding its way to the Atlantic and the second to the Pacific. The Kicking Horse (one of the first explorers was kicked by a horse here, hence the name) River descends very rapidly through a rocky and wooded valley, the sides of which rise almost vertically from the water's edge 5000 or 6000 feet, and required quite a little engineering. Here the nine miles of temporary line before referred to are used to avoid a tun-

nel of 7000 feet. Had the tunnel been adopted in the first place the completion of the railway would have been much delayed.

A liberal policy of the Canadian Pacific Railway may be mentioned. A few years after the road was completed the Board of Directors voted a bonus of $5000 to the late Major Rogers, who discovered the Kicking Horse Pass, a similar amount to Mr. Sykes, who introduced a loop in the line, thus avoiding some heavy grades and cuts, and several smaller bonuses. The entire work in the Kicking Horse Pass was done under Mr. Ross in the summer of 1884. At the foot of this Pass the track crosses Columbia River and ascends the Selkirk Range to 4300 feet when it descends by the Ille cille-waet River (Muddy Water) and again crosses the Columbia River, which makes a detour around the Selkirks. This location saved eighty miles and avoided the cañons of the Columbia. The chief trouble in the Selkirks is due to the immense snow-slides. To prevent the track being completely buried every winter snow-sheds are built. Our original design was to build a shed in a deep cut in such a way that the avalanche would not strike the shed but merely glance over the roof. Where this plan was departed from the strongest sheds were crushed to atoms. A faint

CANADIAN PACIFIC RAILWAY BRIDGE, MONTREAL.



KICKING HORSE CAÑON, ROCKIES, B. C.

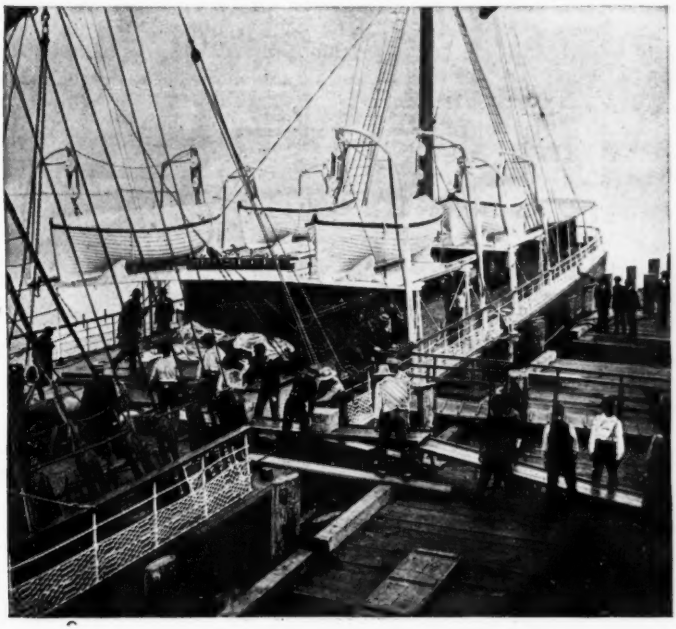
idea of the force of these slides may be obtained from the fact that the trees, on each side of the slide where the snow stands twenty or thirty feet deep, are cut off at the level of the snow, as if with a knife, *by the whirlwind* that accompanies the slide.

A tunnel through a mountain of quicksand in the Selkirks gave trouble, for just as it was completed the mountain shut it right up. After two or three more attempts it was given up and a curve of 23 degrees was run around the mountain. This curve has been operated by all the trains without difficulty. On crossing the Columbia the second time the Canadian Pacific Railway enters the Gold Range, the lowest and easiest to overcome. The broad val-

ley of the Eagle River is much more fertile than the passes in the other ranges. The trees grow to great heights and many of the cedars are over fifty feet in circumference. It was here that the Government's line from the coast met the company's line and the last spike was driven. Between the Gold and Coast or Cascade Ranges is one of the best grazing districts in Canada.

There seems to be no limit to the traffic which the Canadian Pacific Railway will eventually obtain. It already handles coal and iron from Nova Scotia, lumber from Maine and New Brunswick, the local traffic of all Canada, the wheat from the Northwest and our Northern States, the through trade from Asia, and it only needs American capital to develop the vast lumber fields from Ottawa to the Pacific; the rich mines of Lake Superior; the coal of the Bow River and the coal, iron and gold of the Rocky Mountians.

The Canadian Pacific also opens an immense field for the sportsman and tourist. In Maine, Quebec and Lake Superior the

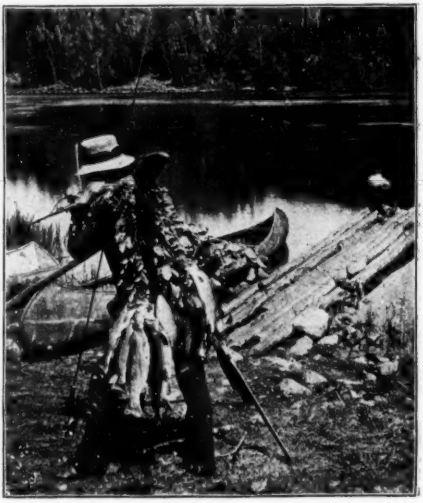


CANADIAN PACIFIC STEAMSHIP "PARTHIA" UNLOADING TEA.

SULKY PLOW IN MANITOBA.

lover of gun or rod can get all the fun he wants as my friend did who was photographed with his morning's catch on his back. As for the scenery, I consider that of the Saguenay and of the Rockies to bear the same relation to the Alps of Switzerland as the Niagara does to the English Thames.

The Canadians certainly deserve great credit for the construction of this railway, especially as they received no help from England whatever. The only thing they now need is annexation, which would at once pour millions of our money into Canada to develop her untold wealth of natural resources.



A GOOD CATCH OF FISH.

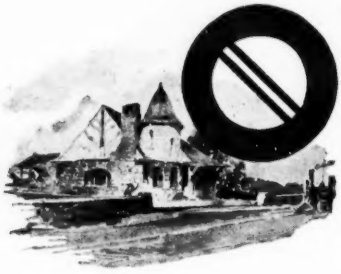
The length of the main line of the Canadian Pacific Railway, from Halifax to the Pacific, is thus given: From Halifax to Montreal, 756 miles; Montreal to Port Arthur 993; Port Arthur to Winnipeg, 431; Winnipeg to Regina, 357; Regina to Calgary, 523; Calgary to the Pacific 702.

It will prove of interest to note how closely the line of this road borders upon the limits of the United States, and how it affords opportunities for competition with through shipments by American railways running East and West. Attention was called recently to the fact in connection with the growing foreign sale of New England's cotton products, that every yard of such goods intended for China is shipped by the Canadian Pacific Railway to the ocean and thence by its line of steamers to the destination of the goods. Should the transatlantic line of steamers be organized, as intended, a similar state of affairs may doubtless be expected in the shipment of our grain and live-stock products across the Atlantic.

MAP OF THE CANADIAN PACIFIC RAILWAY AND ITS CONNECTIONS.

PICTURESQUE SUBURBAN RAILROAD STATIONS.

By Bradford Lee Gilbert.



IF the importance of this subject a sufficient argument may be found in the statement that an average of twenty million passengers have been annually transported during the past two years by the railroad systems of the United States. With the necessary limitation of a magazine article but a cursory glance and a general outline sketch of the subject can be attempted.

Railroads have proved themselves the great "civilizers" of this country, developing towns and cities before unknown, disseminating knowledge of better methods and new ideas, encouraging advance and improvement, increasing enormously the valuation of property, and creating new business centers. The foresight of many railroad companies in controlling and reserving large tracts of land surrounding their stations for parks and other future requirements, at a small original cost, has seldom failed to prove an excellent investment.

But few among the general public are capable of judging of the merits of a railroad by its road-bed and plant, consequently nothing advertises a road better than tasteful station buildings; nothing helps to attract and build up local traffic more quickly. In this age of progress in railroad construction, it is not only in the end the most economical, but throughout, the most advantageous and best paying policy to provide the most convenient and best equipped stations for the public, regardless of cost, considering also the questions of economic, efficient and practicable service as paramount.

No excuse should exempt a railroad company from being amenable to "local pride," any more than another good citizen or permit the erection and maintenance of buildings which are a public nuisance

STATION WITH ROTUNDA, LACONIA, N. H.

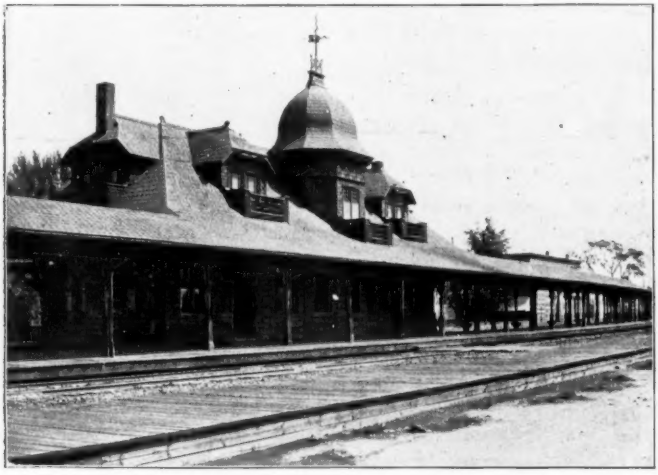
and disgrace. In many cases a "penny wise but pound foolish" policy has been followed, in utilizing the cheapest material and poorest construction, producing what might be termed in politics a "mugwump;" or the buildings as erected might justly be criticised as being "Queen Anne" in front, and "Mary Ann" in the rear, the exterior effect gained by expensive "gingerbread" work, costing more than if tastefully designed and properly executed by some competent architect. Until recently the exceptions to this statement have been few and far between, as one will be fully convinced who travels over the roads extensively.

More important still, where the buildings are badly designed

STATION ON THE OLD COLONY ROAD, NORTH EASTON, MASS.

and arranged, the cost of maintenance and the handling of traffic and passengers is greatly increased at the expense of the road, and the discomfort and annoyance of the public proportionately. It has well been stated that "every one imagines that he can run a railroad, edit a newspaper, or design a house;" while the few successful efforts are recorded, mention is never made of the innumerable failures, but the buildings too often speak for themselves. But better counsels and a broader policy are to-day replacing these crude and erroneous methods on the more advanced roads.

In some cases it is advisable to have uniform "class stations,"

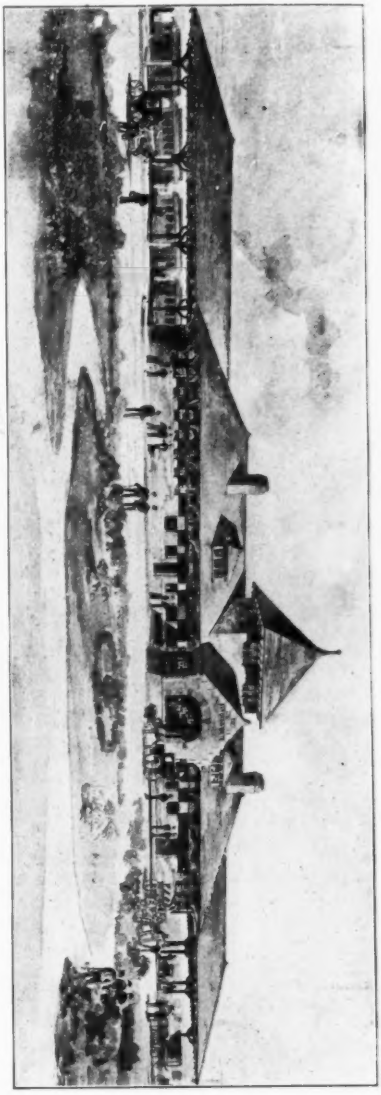


A SUBSTANTIAL STATION AT EVANSTON, ILL.

one of which is shown. In a new country, for instance, where it is difficult to obtain finished material, buildings of a uniform style, and with interchangeable fittings, can be erected more readily and economically. But there can be no reasonable excuse for the "sameness" of new station buildings on completed roads, where material and labor are both accessible. It would seem to indicate both a lack of interest in the subject, or a lazy method of doing business. With little trouble and no additional expense this desirable feature can be utilized for the permanent improvement and popularity of the road, and the convenience of its patrons.

After having been requested to prepare this paper about seventy-five railroad companies and larger "systems" were corresponded with and requested "to co-operate in making this a valuable paper to railroad officials." The results obtained have been numerous valuable suggestions and the greater portion of the illustrations presented herewith, demonstrating a very commendable and satisfactory personal interest among railroad men on this important subject, and commanding our hearty thanks.

It would be difficult to decide which railroad or individual deserves credit for being the pioneer in the improvement of railroad stations. It is certain, however, that railroad architecture, as exemplified in the limited selection of illustrations presented in these pages, as well as the better grade of station buildings to be seen throughout the country, has obtained a marked recognition within the past fifteen years, to the immense benefit of the railroads themselves, and

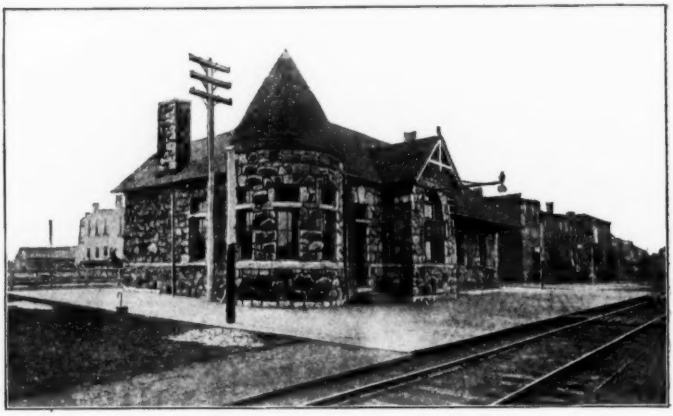


BOWENVILLE STATION, ON THE OLD COLONY RAILROAD, FALL RIVER, MASS.

the comfort, safety and convenience of the public. This improvement is not confined to the vicinity of the larger cities, but is widespread, extending from the East to the West, and the extreme South, even over the border into Mexico, as the illustrations best substantiate. These have been selected as fully as our limited space will allow, to represent a variety of the smaller picturesque stations throughout the country, erected within an expenditure of $40,000.

The initial letter at the head of this paper shows a small station designed for Bernardsville, N. J., on the Delaware, Lackawanna & Western railroad.

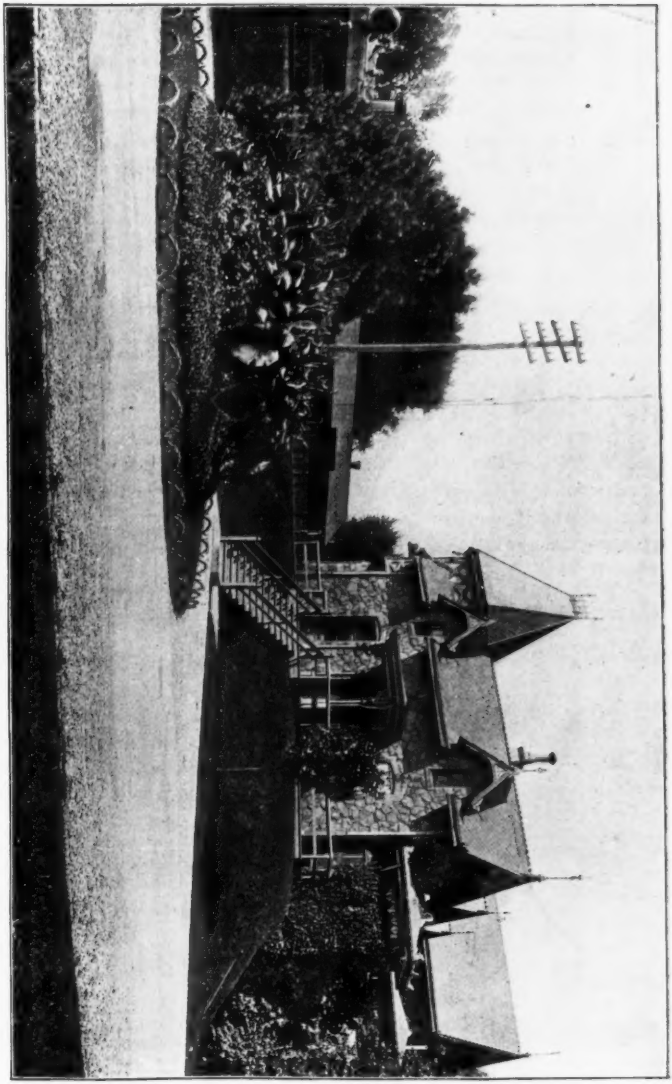
The picturesque station at Battle Creek, on the Michigan Cen-



A PICTURESQUE STATION AT GRASS LAKE, MICH.

tral railroad, is of brick with stone trimmings, with a quaint-looking clock-tower and a *porte-cochere* on the street side. The size over all is about 122 by 31 feet, divided into rooms for men and women with a hall between, ticket-office, and women's private room. Many of the stations on the Michigan Central road are surrounded by handsome flower-beds and gardens, and their wide-awake Chief Engineer has carried out a very desirable and charming feature in connection with these flowers by having small *boutonieres* presented by young girls to passengers as the train stops at many of these stations.

The station at Ardmore, Pa., on the Pennsylvania railroad, is



PICTURESQUE STATION AT ARDMORE, ON THE PENNSYLVANIA RAILROAD.

small but picturesque. The engraving given shows the drive-way and surrounding grounds. The building is of rubble stone, with slate roofs, and is elevated on a terrace, with considerable Gothic feeling in its treatment.

A very novel and effective idea is represented in the "twin" stations at Desroyer and Baker Parks on the Shore Line between St. Paul and Minneapolis, on the Chicago, Milwaukee & St. Paul railroad. The buildings are elevated on terraces reached by wide stairways and platforms, and are about 36 by 20 feet each, with waiting-rooms, and ticket-office, and carry out very forcibly the idea of a suburban station.

The new station at Fall River (Bowenville), Mass., for the Old Colony Railroad Company, is built of Milford pink granite with Long Meadow brown-stone trimmings. The building is 185 by 40 feet, the awnings extending to a length of 330 feet. A special feature has been made of the *porte-cochere* and ticket loggia, a large map of the Old Colony road being shown on the wall over the ticket office. On each side are waiting-rooms forty feet square for men and women, with private, retiring, smoking and dressing-rooms attached, the interior finish being entirely of oak. Large open fireplaces and alcoves are features of the general waiting-rooms. A

STATION WITH OVERHEAD BRIDGE, SEWICKLEY, PA.

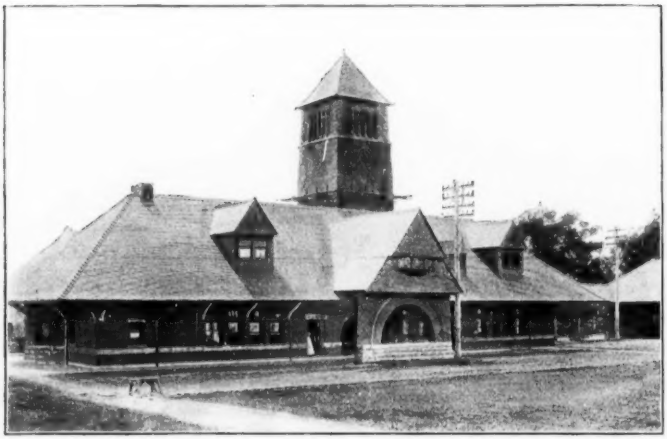
TWIN STATIONS AT DESROYER AND BAKER PARKS, MINN.

baggage-room, together with rooms for trainmen and emigrant service, are also provided.

The station at Sewickley, Pa., on the Pennsylvania lines west of Pittsburgh, shows various gables, a platform for both up and down tracks, with an overhead bridge reaching an awning on the opposite side of the station. The building is about 27 by 70 feet, divided into general waiting-rooms, private room for women, baggage-room, ticket office and other necessary accommodations.

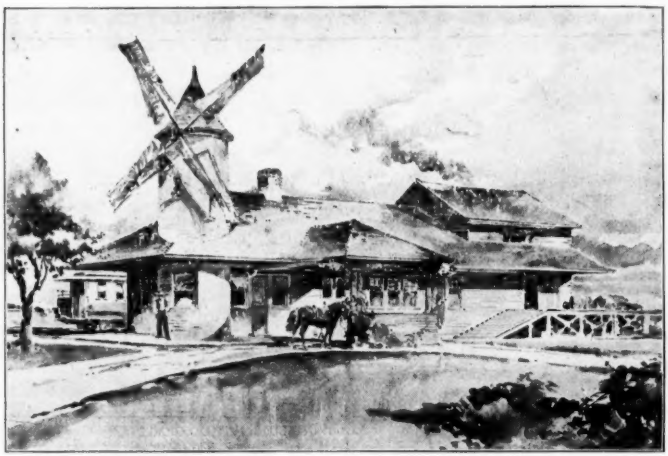
One of the illustrations shown is that of a station at Acambaro, in Mexico, on the Mexican National railroad. It is designed with a strong "modern English" feeling, with long rambling roofs and a generally picturesque effect, in keeping with the general surroundings. The building is about 100 by 40 feet, arranged with accommodation for first, second, and third class passengers, with dining-room on the first floor, and rooms on the second floor for the accommodation of passengers who may be belated. The entire finish is of brick with concrete platforms.

A rather odd station is that of Reed City, Mich., used jointly by the Grand Rapids & Indiana and Flint & Pere Marquette roads. The general waiting-room is in the shape of a large octagon, at one end of which is a lunch-room; on the track sides are the ticket



STATION ON THE MICHIGAN CENTRAL ROAD, AT BATTLE CREEK.

offices, and on the other sides the room for women, with dressing-room off ; smoking-room for men, with dressing-room, and baggage-rooms at each end of the building. The light for the rotunda is ob-



A SOUTHERN RAILWAY STATION, GROVETOWN, GA.

tained from clere-story windows above the roof of both wings. The rotunda is 64 feet square, with wings about 75 feet in length.

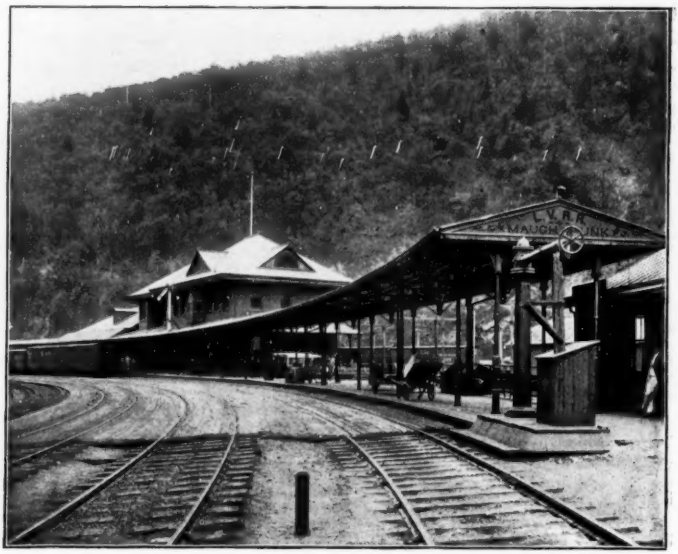
There is a charming station at North Easton, Mass., on the Old Colony road. The design is very effective. The wide arches at the *porte-cochere* and various openings seem to start from the ground as a base. The building is of granite with brown-stone trimmings.

A Southern railway station shown is on the Georgia railroad, at Grovetown, Ga. It is 77 by 24 feet, with class-rooms for white and colored passengers, and a large freight platform for cotton, with baggage-room and toilets. The wind-mill was designed to supply

STATION AT HIGHLAND, MASS.

a tank in the tower with water for toilet and station purposes. The design is picturesque and simple, the material being shingles.

The station at Grass Lake, on the Michigan Central road, is built of field stone or "hard heads" of various shades with broken faces, laid up in rubble-work, the effect gained being delightfully quaint and picturesque. The building is 63 by 34 feet, divided into a general waiting-room, women's-room, etc. A special feature of the station at Laconia, N. H., on the Concord & Montreal railroad, is the rotunda, forty feet square, with octagon corners carried up above the roof, with light coming in from the clere



A STATION ON A CURVE, LEHIGH VALLEY RAILROAD.

story windows overhead. The floor of this rotunda is of marble, a large chimney forming one of the features. Of "Class" stations, a good example is shown in a frame building at Providence, Pa., on the New York, Ontario & Western railroad. It is simple, neat, and effective. The size of the building is 24 by 64 feet, divided into a waiting-room, freight-room and ticket-office.

The station at Galesburg, Ill., on the Santa Fé road, is built of brick and stone, with projecting awnings and gables. The size of the building is 54 by 168 feet. It is divided into rooms for men and women, ticket-office, carriage-porch, baggage and express-room.

The Wichita (Kansas) station on the Santa Fé railroad is a picturesque building of stone. The corner tower gives a very pleasing effect, with wide awnings on the track-side. The building is divided into rooms for men and women, lunch-room, etc., the plan being very complete. The size of the building is 60 by 156 feet.

A simple, solid and substantial design is shown in the station at Evanston, Ill., on the Chicago, Milwaukee & St. Paul railroad.

STATION AT WICHITA, KANSAS.

It is about 68 by 21 feet, built of stone with metal shingles on the roofs and sides of the dormers and tower, where projecting above the roof. Some of the posts of the extension platforms at either end of the building are furnished with seats—a rather novel and good idea.

The station at Highland, Mass., on the Old Colony railroad, is a picturesque building, with large gable and chimney of stone, with roofs of slate. The design is quaint, showing constructional outlines and a graceful contour.

This general description of the various buildings is intended to assist in the understanding of the illustrations presented in this paper.

Based upon intimate professional relations and personal contact with some of the leading railroad officials of this country, including the best informed, for twenty years past, I believe that the following general principles and requirements, suggested in connection with suburban and smaller stations, will meet with the general approval of railroad men as forming a basis upon which to judge fairly the merits of similar buildings, or their requirements when their erection is contemplated :

The station, first of all, should be designed in connection with its proposed location, the actual requirements of traffic, the proper material most readily obtainable, and *not to exceed the limit of appropriation.*

STATION AT GALESBURG, ILL.

Whatever architectural effect is desired or attempted should be gained entirely by a bold, original treatment, suitable to the surroundings and conditions, and by means of constructional outlines and a graceful contour, not by ornamental or "fancy" detail work.

Whether the building is constructed of stone, brick or wood,

the material should be first-class, suitable and selected with special reference to the locality.

The requirements of the ground plan in all cases should be determined by the present population and probable growth of the town or city where located, the number of trains daily, and the number of passengers and pieces of baggage handled.

JOINT STATION, REED CITY, MICH.

It would be impossible, for obvious reasons, to suggest any "rule" which might guide in the arrangement of the various rooms and general ground space, other than a few general recommendations, such as follow.

If but one general waiting-room, or rotunda, is provided, a larger private room should be arranged for "women"—let us discard using the much abused word "lady" in connection with public buildings. This arrangement is found desirable as a matter of privacy and convenience. Whether or not a separate room is provided for women, they should always have a comfortable private room, connected with a generous dressing room.

The ordinary "men's waiting-room" is too often utilized as a smoking-room and becomes exceedingly objectionable to men who do not smoke; consequently a general waiting-room, or rotunda, for both sexes, is desirable. It will generally repay the expense to provide a pleasant room for "smoking," as a comfortable seat and a good "smoke" attracts the least desirable element (laborers, hackmen, etc.), which are thus easily provided for, outside of the general waiting-room. It also affords greater privacy to have the men's dressing-room open off the smoking-room.

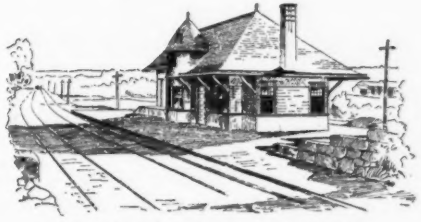
Large pleasant open fireplaces, of tasteful design, for use on chilly, damp days, as well as for ventilation, will be found a most desirable acquisition and feature in all waiting-rooms. Small alcoves arranged off the general waiting-rooms, by means of screens, are much appreciated for the convenience and privacy of wedding or funeral parties.

STATION AT ACAMBARO, MEXICO.

Next in importance should be considered the ticket-office.

When the agent acts as telegraph operator as well, the office should always be located on the track-side of the building, provided with a projecting window affording an unobstructed view of all tracks, and elevated enough to overlook passengers standing on the platforms. A convenient arrangement of ticket windows is also desirable, within reach, without moving, and with ample light and generous counters. Each agent generally entertains rather positive ideas as to what is most desirable, and to a reasonable extent it is generally best to adopt his suggestions. If the station agent and telegraph operator are in separate offices this arrangement of location should, necessarily, be reversed.

The baggage-room cannot be made too convenient for the rapid and least expensive method of handling baggage. A suitable space for the express service is also necessary, unless located in a separate building. A small mail-room in addition will prove very desirable. A room for conductors and trainmen is highly appreciated, as well as restaurant accommodations when required.



EXAMPLE OF CLASS STATION, AT PROVIDENCE, R. I.

The provision for heating and ventilating cannot be given too thorough study. The plumbing and sanitary work should be first-class in every particular. Marble or slate on the floors and side-walls of dressing-rooms will repay the first cost after a few years' usage. Provisions for coal storage-and a room for oil and lamps (where required) should not be overlooked.

Last, but not least, ample provision should be made for covered concrete platforms carried around the building, and wide enough on the track-side to prevent injury to passengers from baggage-trucks, or the possible addition of an extra track, and long enough to accommodate an ordinary train of six coaches. Arrangements for the accommodation of carriage traffic, either by means of projecting awnings, or a generous *porte-cochere*, are always desirable.

THE MANCHESTER SHIP-CANAL.—II.

By George R. Dunell, C. E.

THE Manchester Ship-Canal is the largest work of its kind ever undertaken in England and from this point of view is an enterprise of great interest to engineers. There is something impressive about a very big thing simply from the fact of its bigness; and when one remembers the vast quantities of mother earth that have to be removed before a shipway can be made which will take large vessels up to the inland city of Manchester, the undertaking presents something of an heroic aspect to the mind, although there are no valleys to be crossed or hills to be cut through. It is true that in order to make the canal, a fair-sized river—as rivers run in England—will have to be annihilated and its course turned into the new artificial water-way; but the great obstacles that have to be overcome are those of man's, and not Nature's, construction. The railway deviations, the swing road-bridges and a swing aqueduct are the chief things that absorb the engineer's attention.

On another page are given a plan and section of the canal from end to end. The vertical scale of the latter is greatly exaggerated compared to the horizontal scale. The difference is as between 1 and 66; so that on the engraving the rise of locks, depth of canal and other vertical distances are sixty-six times as great as they would be were the scales the same as that of the horizontal distances. The canal is 35½ miles long; the minimum depth is 26 feet and the width at the bottom 120 feet.* The excavation amounts to 46½ million cubic yards, of which over 10 million are sandstone rock. It is in the latter respect that this canal differs so greatly from the great artificial water-way which now divides Asia from Africa. In the Suez Canal the material excavated was sand mostly, and the most effective method of dealing with this was by dredging; so that as soon as the dredges could be got afloat the engineering problem was to a great extent solved, and the work that remained was to be overcome by patient and dogged endurance. Nevertheless sandstone rock is, in many respects, a more satisfactory ma-

*The depth of the Suez Canal is 26 feet and the original width 72 feet. The Amsterdam Ship-Canal is 89 feet wide and 23 feet deep.

terial to deal with than loose sand, for one feels pretty sure that when once removed it will stay where put. It may be added that the first sod of the Manchester Ship-Canal was cut in November, 1887. When the work will be completed is in the womb of the future. It is a subject upon which the authorities are very reticent but certainly it will be beyond date.

As will be seen by the plan the canal has two phases of existence. For the lower third of its length it skirts the Cheshire shore of the Mersey Estuary, here and there cutting through projecting headland, or, where there are bays and inlets running across them; the canal bed there being formed partly by walls and partly by excavation. This is the system of construction which is followed until the Mersey Estuary narrows into the reaches of the river proper, just above the towns of Widnes and Runcorn; perhaps the two most unlovely towns in this by-no-means beautiful district. Here the canal passes under the Runcorn Railway Bridge, a lofty viaduct which is one of the most notable features in the railway journey between London and Liverpool. This is the first phase of the canal's course—running sometimes through the land and sometimes through the sea—quite an amphibious career, which seems a strange thing for a shipway.

Ellesmere Port is the name given to the embouchure of the old Shropshire Union Canal into the Mersey Estuary. The outer embankment of the Ship-Canal cuts right across the bay in front of the port. The nature of the shore here is such that the mud and sand are quite unable to support unaided the weight of an embankment, and therefore a strong timber hearting had to be constructed. This is 1¼ miles long and contains about 650,000 cubic feet of timber, which will of course be buried in the ballast forming the bank. At Eastham Locks, near to the sea end, the work is wholly in the land and is, consequently, pure excavation. Here the outer bank of the canal is formed by the narrow strip of natural land left between the canal and the estuary.

The second phase of the canal's existence occupies the greater part of its length and consists of the wholly inland work. Here the operations are of an entirely different nature, and more resemble ordinary canal work, whilst the estuarine sections partake of the nature of harbor construction. We will, however, give the chief features of the work in order, but this must be in brief outline as the varied nature of the operations would require a lengthy treatise to describe them adequately. We will begin at the lower end of

the canal, where it debouches into the Mersey Estuary, the entrance being formed by the Eastham Locks. Here three locks are placed side by side, the largest being that on the landward side, next to the sluices. It is 600 feet in length between gates, and 80 feet wide between coping lines; so that even the Atlantic leviathans which the Cunard Company have just ordered would not be too long to pass, supposing nothing were required for clearance. The length of the lock wall from end to end is 789 feet. The middle lock is 50 feet wide between copings and 350 feet long between gates. The smallest lock is 30 feet wide and 150 feet long. All three locks are 49 feet from coping to invert. There are three locks of different sizes, the smallest being for barges and coasting-vessels, because it would be undesirable to waste water by passing a small craft through the big lock.

The lock walls are composed of concrete 8 to 1, with a facing of 4 to 1. The stone work is of sandstone and granite. There are grooves, so as to facilitate the building up of dams, should anything happen to the gates. All the sluices are on the now well-known principle introduced by Mr. Stoney, in which the shutters run on rollers hung on frames, an arrangement which permits a sluice, with the pressure of a considerable head of water against the face, to be opened with comparatively small expenditure of power. The eight inlets for the emptying sluices are oval, 7 feet by 4 feet, and the culverts are also oval, 12 feet by 6 feet. The filling sluices are of the same description. The lock gates are of greenheart throughout; and are noble examples of timber construction, as will be gathered from the following dimensions of the 80-feet gates. There are in each leaf 180 tons of timber and 30 tons of metal-work in the shape of clamps, straps, etc. The thickness in the centre is not less than 5 feet, but tapering to each side. The object of giving this arched section is to give a better distribution of material to withstand the stress due to pressure of water. The length of each leaf is 45 feet, and the height from top to bottom rib 48 feet. The largest pieces in these gates weigh from $1\frac{3}{4}$ to 2 tons when ready to work in. Most of the metal-work is of steel.

There are in all five sets of locks, the total rise being 71 feet 6 inches. Eastham Locks have a rise of 11 feet; Latchford, the next, 16 feet 6 inches; then follows Irlam, 16 feet; after that Barton, 15 feet, and finally Manchester Locks, with a lift of 13 feet. The four up-stream locks are generally of the same description as those at the entrance, the difference being chiefly in dimensions

The arrangement is two locks placed side by side, one 600 feet long and 65 feet wide, and the other 350 feet long and 45 feet wide. In the big lock there are intermediate gates to cut off, 150 feet in length. Hydraulic machinery is provided for operating the locks. This has been contracted for by the great Elswick firm of Armstrong, Mitchell & Co., who are now perhaps better known as constructors of warlike material, although it will be remembered that Lord Armstrong first won renown in the field of hydraulic mechanism.

From the entrance at Eastham to the next set of locks, at Latchford, the canal will be semi-tidal. This has been necessitated by the provisions of the Act of Parliament in virtue of which the Canal Company works. It was said by the opponents of the canal that abstracting anything from the volume of ebb and flow would lead to the silting up of the mouth of the Mersey, and it was round this point chiefly that the Parliamentary battle centered. As the canal in places cuts across bights of the estuary, it is clear that the basin would be reduced were not openings made in the outer wall. This, therefore, has been done, so that all tides rising over 14 feet over datum at Liverpool will flow through the openings into the canal. The maximum rise and fall of tide in this part of the canal will be 18 feet. By provision of the Act of Parliament, also, the total water for the canal—except of course that tidal water flowing through the openings as mentioned—must be supplied from above Runcorn, the law requiring all land water below to be discharged directly into the estuary. There are many small tributary streams and these have to be taken under the canal. For this purpose inverted syphons have been constructed in brick and iron.

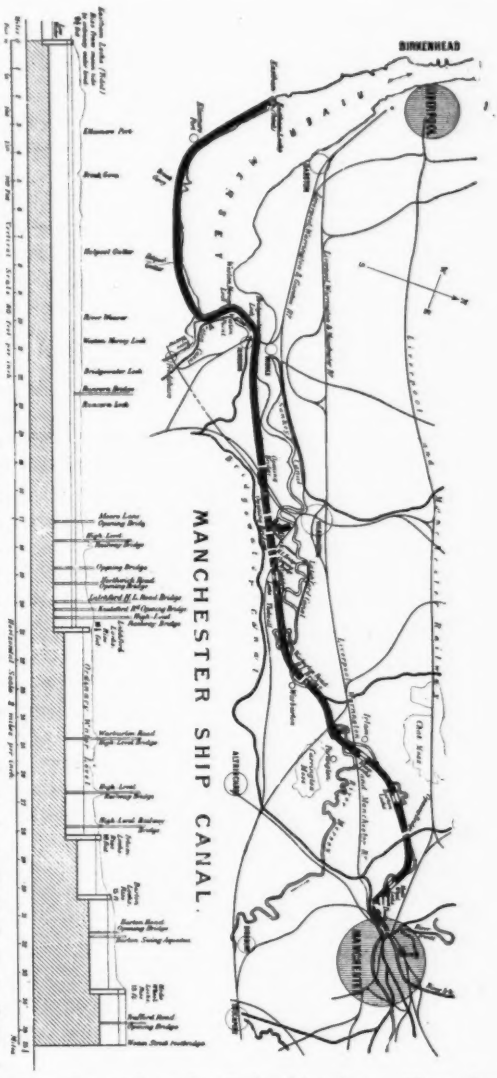
We must forbear here describing the swing-bridges which, in the upper part, carry the principal roadways of the district over the canal. These bridges have many interesting features and are 120 feet clear in the opening. The railway deviations also form in themselves a big work. It will be easily understood, with railway lines so heavily worked as those in the busiest part of the busiest district in England, that swing-bridges would be out of the question, and all railways crossing the line of the canal have had therefore to be raised so as to give the 75 feet height in the clear which has been adopted as the standard. In some cases the work is rendered much more difficult by the railway lines being diagonal to the canal, so that the bridges have to be constructed on the skew, in one case as much as 26½ degrees.

The new canal will interfere with more than one previously existing water-way, and ample provision has been made by Parliament to protect them. The Bridgewater Canal, Brindley's great work—great as a pioneer work of engineering construction—had to be purchased outright. The navigable river Weaver has had special clauses inserted for its protection, and satisfying these has not been the least of the engineering difficulties. The "Weaver Navigation," to use the local term, is a highly-interesting piece of water. In the first place it carries on a most successful rivalry with two or three railways, a most unusual thing in England. Secondly, it is administered by no less than 105 trustees who are chiefly composed of the principal landowners of the neighborhood. It is a public trust, and the profits made, which are not insignificant, go towards reducing the rates and taxes. Perhaps the most remarkable part of this trust is that the board is self-perpetuating, and it speaks well for this system that the Weaver Trust is generally approved and carries on its business to the general satisfaction of the public. From an engineering standpoint this little river is also interesting. Its traffic is considerable, no less than a million tons of salt alone having been carried by its waters in a single year; but then salt is the staple product of this district. The locks and sluices of the Weaver are fine specimens of construction and have served in many details as models for similar work on the Ship-Canal. It was to connect the waters of the Weaver to the higher-level water of the Trent and Mersey Canal that the first lift to raise and lower boats afloat was made.

The Weaver is also interesting from the difficulty experienced in keeping it above ground. The river passes through one of the most important brine-pumping districts in England, and when brine is pumped up the space occupied by the salt so abstracted is apt to be filled by subsidence from the surface. For this reason the stone bridge carrying the Queen's highway over the river at Northwich has had to be lifted on more than one occasion, for fear it should share the fate of some neighboring buildings, and be engulfed entirely. The river banks have continually to be built up for the same reason in the neighborhood of the pumping operations. At the Weaver mouth the Canal Company have had to construct a lock to connect the river with the Western Canal, and there has also to be a lock in the embankment in order that craft may pass from the Weaver direct to the river Mersey, or if preferable, vessels may go down the canal to Eastham or up to Manchester. The

Canal Company are also compelled to pass all the water from the Weaver direct into the Mersey, and for this purpose openings have been made in the embankment.

The docks that have been constructed on the line of the canal are extensive works. The most important are those at Manchester, on which the excavations are now in a fairly advanced state. Near Partington the canal is widened out to 60 feet on each side, so as to form a basin which is intended to contribute an important coaling depôt, opening out to the sea the extensive Lancashire coalfields. This it is thought will have a most important influence upon the coal trade of the kingdom. Near the



ancient town of Warrington there will also be important docks capable of accommodating a large amount of tonnage. In other parts also the canal is widened out beyond the standard width. It should be stated that up to Warburton [see plan] the river Mersey and the canal are separate water-ways; above that up to Manchester the canal swallows up the river, occupying its bed where it is fairly straight, while the reaches that are too winding will be filled up with spoil.

A little above Barton Locks, between 3 and 4 miles below Manchester, there are two of the most interesting features in the canal. These are the swing-aqueduct which takes the old Bridgewater Canal over the Ship-Canal and the hydraulic lifts by which barges can be transferred afloat from the lower level of the Ship-Canal to the upper waters of the Bridgewater Canal. We will treat of the former work first. When Brindley constructed the Bridgewater Canal it was necessary, in order to carry out his plans, that the canal waters should cross the Irwell at a higher level than the surface of the river, and in order to do this he adopted the then bold expedient of making a stone bridge across the river, but in place of a roadway he constructed a trough which formed the bed of the canal. The thing seems simple enough to us now, but our grandfathers must have looked upon the hanging of a river in the air as something truly great and original. But Brindley had not to get across a piece of water that was destined to carry ocean-going ships, and in order to meet this contingency Mr. Leader Williams has had to strike out on a new line. As Brindley adopted the design of a fixed bridge of his day, transforming it into a fixed water-way, so Mr. Leader Williams has transformed the swing-bridge of the present era into a swing-water-way. The thing is simple enough in principle but it will be quite a big thing to carry out. There will be, however, an alternative means of carrying the Bridgewater traffic at this point, and this will be by the use of the hydraulic lifts already mentioned. As this device has already been adopted more than once since Mr. Leader Williams—who was then Engineer to the Weaver Navigation Trust—introduced it at Anderton, there is less boldness in adopting it. There are many other features in the design of the canal, but they must be passed by for a brief mention of some of the appliances used in excavating the canal.

The number of men employed on the Ship-Canal has never exceeded 17,000 and not over 200 horses have been in use; and as 46½

million cubic yards have to be excavated it is evident, as Mr. Leader Williams said at the last meeting of the Institution of Mechanical Engineers at Liverpool, that mechanical appliances would have to be largely used were the canal to be finished in anything like reasonable time. Ninety-seven steam excavators and eight steam dredges of large power have been employed. There are also 124 steam cranes, 192 portable and other steam engines and 212 steam pumps, some of the latter being large Cornish pumps. The plant consumes about 10,000 tons of coal per month. For removing spoil and general purposes 173 locomotives and 6300 trucks and wagons have been used; while 228 miles of railway have been specially laid for the work of construction. The total cost of the plant has amounted to £943,610.

The greater part of the excavating has been done by steam navvys made by Ruston & Proctor, of Lincoln. We believe the steam navvy to be an American invention brought to England by Mr. Dunbar some years ago, since which time many improvements have been made. It will work better in hard ground than any other machine, and can deal with soft sandstone rock without blasting, although much of the stone through which the Ship-Canal has been cut is too hard to be worked without blasting. The digging buckets for sand excavation will hold 2¼ cubic yards. These machines are self-propelled and cost about £1200 each. With good material they will excavate 2000 cubic yards in ten hours. The working expenses are about 30 shillings per day.

The most interesting machines on the ground, however, are the French and German excavators or land dredgers. There are four of the French machines and three of the German type. The principle in the French machines is similar to that of an ordinary ladder-and-bucket floating dredger, such as used almost universally for harbor work. In place, however, of a floating hull we have a small wooden house mounted on wheels which run on a railway laid on the top of the bank. The buckets go round on a continuous chain—working, however, in a direction opposite to that of a floating dredger, and as they scrape the face of the bank they pick up the spoil which is deposited into railway trucks on the line. The German dredger is similar to the French machine in general principle, but the former is, we think, of a better design, being more stable on its base; but Mr. Leader Williams tells us the Frenchmen put better work into their job. These land-dredgers are only fit for fairly light soil and the Frenchmen have gone right over into the cut-

ting, a circumstance which should give a contractor an opportunity to display his command of resource and language. Mr. Leader Williams tells us that the first cost of a "Frenchman" is about £2400; and the best day's record is 2250 cubic yards, while the average is put down at 1500 cubic yards. For this rate of working the daily expenses in coal, stores and repairs were about 60 shillings per day for each machine. There are employed to each machine an engine-driver and a stoker, and roundabout from 28 to 43 men, the average being 35. The German dredger traverses fast enough not to require the supplemental locomotive, and does not tip over into the cutting if the bank becomes at all rotten. The best day's performance has been 2400 cubic yards, but the average is 1416 cubic yards with an average of 36 men.

Before concluding this article on the Manchester Ship-Canal, we should like to have said something about the men who have taken the leading part in its inception and construction. Every great engineering work, in every age, bears the impress of some master hand. Even Father Noah is displayed to us by the first great engineering enterprise the world ever saw, a cautious canny man, but with a brain to plan a big enterprise and courage to carry it through. In the Manchester Ship-Canal we have the material embodiment of the spirits of two characteristic Englishmen; one gone, Daniel Adamson, but the other happily still left to prosecute the work, we all hope to the end. It is ill praising a man before his face, and were we to say what might be said about the present Chief Engineer of the canal* it would be nothing but praise. Of the late Daniel Adamson we can only speak with respect. It was epigrammatically said of him "That had he not taken the Manchester Ship-Canal up it would never have been commenced and had he not put it down it would never have been finished." He was a man of absolutely unbounded energy, iron will and perfect honesty of purpose. Like many other strong characters he made little allowance for the weakness and prejudices of others and consequently made many enemies. In his latter days he lived only for the Ship-Canal and when he was deposed from the leadership his fiery spirit soon burnt itself out.

* Reference is made here to Mr. G. Leader Williams.—EDITOR.

IMPURE WATER AND PUBLIC HEALTH.

By Floyd Davis, E. M., Ph. D.

ALL natural waters contain mineral salts, some of which may be deleterious to health, but the most injurious foreign substances found in ordinary drinking-water are decaying organic matter and sometimes infectious micro-organisms. All water that is used for domestic purposes has been, at some period, atmospheric vapor, and, as it fell in rains, carried with it the impurities from the air. These impurities are gases that arise from combustion, fermentation and decay, and particles of dust and decomposing organic matter. Bacteria are also removed from the air in great numbers, nearly all of which are in the stage of spores instead of adults. The spores of fungi and other microscopic plants and the pollen of flowers and grasses are also found in rain-water. So numerous are these impurities in the air that a litre of water which falls at the beginning of a storm often contains more than 200,000 micro-organisms. Half a pint of water frequently condenses out of three or four thousand cubic feet of air, and in its condensation removes nearly all of the atmospheric impurities, concentrating them in the water. So in drinking a glass of rain-water that falls at the beginning of a storm we may swallow as much filth as we breathe from the air in more than a week.

If rain-water is stored in cisterns without purification these substances soon render it so foul that it cannot be used for drinking. But when rain is collected near the end of storms, and is properly filtered and aerated, it is one of our most wholesome natural water supplies. As rain falls upon the earth it washes away the accumulations of débris from the surface of the ground, and as it passes into the soil extracts from it a large amount of impurities, such as the products of decaying vegetation and animal excrement. These substances are carried down into the circulating currents, and it is not infrequent that the drainage from cesspools and privies also finds a direct entrance into surface-wells.

In rural districts and small towns, surface-wells are most frequently used as a source of drinking-water. These wells depend for their main supply of water upon the area immediately surrounding them. Their drainage section is similar to the contents

of an inverted cone, the bottom of which is the surface of the ground and the apex the bottom of the well. In porous soil the drainage area is large and the water is consequently often very impure. In compact soil the level of the ground-water may be influenced by frequent pumping for several hundred feet around the well, while in loose, gravelly soil the circle of influence has been shown to have a radius of several thousand feet. By extracting enough water from such soil, currents circulate toward the centre of influence and wash the accumulated impurities into the well. In our northern latitude surface-wells are generally situated in drift-gravel which offers but little obstruction to the passage of filth. Surface-wells are often too close to dwellings, stables, cesspools, and other filth accumulations—agencies of contamination which should never be within the drainage area of a well.

The abundance of filth in cities renders the soil unfit for the filtration and storage of drinking water, and surface wells in such places generally furnish the most polluted and dangerous supply. The sinking of wells and privy vaults side by side on the same lot in towns and even in some cities is not uncommon. In one case where I examined water that produced typhoid fever the well was within ten feet of the privy, and yet the inmates of the house had not suspected any contamination of the water. Into the shallow cesspool is generally deposited all the waste liquids from the house, while from a deeper pit, called the well, sunk below the water line, is drawn all the water that is used for drinking purposes. In such cases the contents of the privy and cesspool gradually soak away and mingle with the ground water that flows to the well, and it is not strange that such wells rarely become dry. We have had occasion to examine surface well water so polluted that under the microscope hair, epithelial cells and an abundance of excreta was observed, and yet people with pallid faces and weak constitutions were using it as if it were of crystalline purity. Our attention is frequently called to this class of wells on account of their waters being such important factors in promoting disease. Excrementitious liquids at first are disgusting to the senses of taste and smell, but unfortunately they acquire palatability after soaking through a few feet of soil, so they are often used without suspicion of their nature until an outbreak of fever attracts public attention.

Cemeteries in some localities are also dangerous agencies for polluting water. It is well known that soil which contains decay-

ing animal matter may contaminate ground water for a great distance in the direction of the flowing currents. Under no circumstances, then, should a cemetery be located among the dwellings of the living, nor should the drainage from it be permitted to enter a stream from which water is drawn for domestic purposes. In the location of a cemetery the topography of the adjacent country and the nature of the soil should be carefully examined with reference to drainage and water supply, that the health of the living may not be sacrificed to furnish a resting place for the dead.

Running water, on account of its agitation and exposure to air and sunlight, loses much of its organic matter or pabulum that accompanies zymotic infection; but it is doubtful whether these agencies of purification have any marked effect in removing microorganisms. Polluted natural soil has also but little effect in removing organic matter from water, on account of the insufficiency of active oxygen in it. The investigations instituted by the National Board of Health and by other sanitary organizations also show that average soil has but little, if any, power to remove bacteria from water. So the contagion that may enter ground water from cesspools often passes uninterrupted to water supplies there to gain admission into the system of unsuspecting victims.

Many contagious and infectious zymotic diseases are now known to be produced by water polluted with decomposing animal matter, and it is highly probable that certain diseases are seldom produced in any other way. Cholera and typhoid fever are typical filth diseases that are communicated through air, food and water, and their origin is generally the result of ignorance, carelessness or superstition. Cholera infection has its inception in the excretions of cholera patients. Only few early investigators considered drinking water the carrier of this infection, but all the most virulent cholera epidemics of the last half century have been traced through polluted water to previously existing cases. This is especially true of Asiatic cholera, which originates at the encampments of the ignorant and superstitious pilgrims of India, where thousands fall victims to its ravages at each of their gatherings. In India the drinking water is derived from stagnant wells and ponds and streams which are generally sluggish and filthy. The water in all of these is used also for ablution and for washing soiled clothes. Some of the water-courses are considered sacred, and it is the religious duty of millions of pilgrims to gather annually on their banks for worship, and in the waters they bathe and cast their dead. Disease invari-

ably breaks out among the pilgrims during their stay. The largest of these religious festivals occurs during the rainy season. The streets and alleys are then flooded with filth, and the superstitious pilgrims are forced into the vile tenements. According to Hunter's "Orissa" these tenements are mere hovels built upon mud platforms about four feet high, and in the centre of each is a hole which receives the filth of the house, and around which the inmates eat and sleep. Upon these platforms are built rooms without windows and without means of ventilation. In some of these cells, thirteen feet long by ten feet broad and six and one-half feet high, as many as eighty persons are said to pass the night. Of the 300,000 people who visit Juggernaut each season, 90,000 are often packed away for a week in these hideous dens. Here the scenes of distress and suffocation baffle description, for the dead and the living are huddled together. Cholera invariably breaks out and the filth and excrement of the patients are washed into the water-courses. During these encampments the mercury ranges from 85° to 100° F., and the dead bodies that are left in the field or thrown into the streams immediately undergo putrefaction and spread the disease by polluting the waters. So it is evident that through the superstitions of these people this dreaded epidemic arises and is spread over the whole of Hindostan every year by these great armies of filthy votaries; and India well deserves its universal reputation of being the birthplace and settled home of cholera.

While Asiatic cholera is a terrible plague, and we are occasionally alarmed at its introduction into Europe and the possibility of its reaching our shores, we generally remain oblivious to the ravages of typhoid fever at home. This fever is far less malignant than cholera, but is also usually produced by the agency of polluted water. In speaking of the transmission of typhoid fever, Sir William Jenner, the distinguished etiologist, says: "I have never seen a case removed from its place of origin, spread to the inmates of the house into which it was removed, unless there was a direct communication between the source of drinking-fluid and the bowel-discharges of the patient."

In the fall of 1887 typhoid fever was epidemic in Ottawa, Minneapolis, Pittsburgh and many other American cities, and in every case known to us the disease was traced to polluted water. In Pittsburgh the south side of the city was furnished water from the Monongahela River, and the fever was located in this district. Through chemical and biological examinations of the water the

pollution was traced many miles above the city to a ravine into which drained the privies of several houses where typhoid fever patients had been located several weeks before. A similar but more noted case than the above occurred in the little mining town of Plymouth, Pa., a few years ago, in which about 1300 of the 2000 inhabitants came down with this disease. Investigation showed that a sporadic case of typhoid fever had occurred several miles above the town and that the excretions of the patient were thrown into the stream that formed the water supply of Plymouth.

Another instructive epidemic of typhoid fever occurred in August, 1872, at Lausen, Switzerland, in which the village water supply was the agent of transmitting the disease. It was found that all the houses using well water in Lausen were free from the fever while scarcely one of those using the village supply escaped. Investigation showed that typhoid fever had occurred at a farm-house about a mile distant, on the opposite side of the Stockhalden, and that the drainage from the house went into a brook that was absorbed in the mountains. Large quantities of salt and flour were thrown into the stream. The salt was soon detected in the Lausen supply, but not a trace of the flour could be found. The presence of the salt in the spring showed its connection with the polluted mountain stream, while the absence of the flour showed the thorough filtration of the water in passing through the mountain. These results show that the most thorough filtration through natural soil is insufficient to remove the typhoid infection from polluted water.

These and similar cases point to the fact that the excretions from a single typhoid-fever patient are sufficient to poison the water supply of a whole town, and to give rise to an extended outbreak of fever. It is therefore apparent that any water contaminated with drainage from sewers, cesspools or privies, or which has been in any way polluted with products of the human body, should never be used for drinking. As soon as the effects of these waters are known by the people, surface wells and other polluted water supplies will be abandoned by the intelligent classes. In some eastern cities the annual death-rate from typhoid fever is proportional to the amount of sewage that enters the public water supply. Thus, a few years ago the annual death-rate from this disease per 100,000 inhabitants in Brooklyn was about fifteen; in New York City, twenty-five, and in Boston, forty; and these numbers are approximately proportioned to the sewage ratio of these waters. Through the improvement of water supplies the rate of mortality

is always lessened. This was very noticeable with the city of Vienna, which, from 1851 to 1874, used impure well water, and a supply from the Danube, while the annual death-rate ranged from one hundred to three hundred and fifty per 100,000 people. But now the city is supplied with pure water brought from springs sixty miles distant, and the annual death-rate from typhoid fever during the last few years has reached only eleven per 100,000 inhabitants.

The annual mortality from typhoid fever in the United States is about 30,000, while some 300,000 people are afflicted with the disease. So great is the devastation from it that in some of the Eastern and Central States about 1000 persons die each year from this terrible plague. But cholera and typhoid fever are not the only diseases attributed to water, for there is abundant proof that polluted water has been instrumental in the spread of malaria, diphtheria, scarlet fever, dysentery, diarrhœa, cholera infantum, cerebro-spinal meningitis and continued fever.

Such are the origin and effects of impurities in drinking water. But decaying organic matter is not known to be the direct agent of these diseases. It is true that nitrogenous animal substances when undergoing decomposition give rise to cadaveric alkaloids which are among the most poisonous of all known compounds. These likely exist in all polluted water, but they are in such minute quantities that it is probable they have scarcely any ill-effect in the system. The organic matter in water is the agent of accumulating infectious micro-organisms which indirectly are the real agents of zymotic diseases; and these impurities are therefore rather the conditions which favor an outbreak of typhoid fever or other filth disease than the agents themselves. By their slow action these impurities may render the system especially susceptible to zymotic infection, but further than this we have no real knowledge of their effects.

It is now almost universally admitted that bacteria or microbes are the indirect agents of all zymotic diseases, such as cholera, typhoid fever, diphtheria, scarlet fever, erysipelas and tubercular consumption. These germs belong to the domain of botany and are the simplest and minutest organisms of which we have any knowledge. They inhabit nearly all kinds of matter; they are always found in the air we breathe, the food we eat, and even the purest natural waters are never free from them. Bacteria are also the most prolific organisms of which we have any knowledge, for a

single bacterium may become the causative parent of more than 16,500,000 descendants in a day. They are also possessed of great vitality, for they can be carried great distances in water without losing the power of producing disease. It is difficult to annihilate some of these germs, for they can be frozen or even boiled without being destroyed. They may be kept dried for years, and yet when placed in a suitable medium will produce fermentation and decay, or if pathogenic, disease.

We are fortunate that only few bacteria are disease producing; the great majority of them are harmless and beneficent objects in nature. They are the principal agents of oxidation of organic matter, and it is to them that we owe the phenomena of fermentation and decay. They are the common scavengers of the earth. Were it not for their constant and beneficent work the world would soon be choked up with decaying animal and vegetable matter, and all the higher orders of life would perish.

But the infectious bacteria have the power of elaborating nitrogenous poisons, known as ptomaines, and the question whether zymotic diseases are produced by bacteria themselves or by these ptomaines cannot in our present imperfect state of knowledge be answered with certainty. In some cases, however, the disease seems to come from the organic poison. Thus tyrotoxicon, which is the alkaloid produced by bacteria in the fermentation of milk, produces a complexus of symptoms in the human system resembling those of cholera infantum, so it is veryprobable that tyrotoxicon is the chemical irritant producing this disease. What is true of cholera infantum is perhaps also true of typhoid fever and other filth diseases, but not at the same stage of life.

All bacteria feast upon organic matter, and develop in great numbers in fermenting solutions of it. Their number is generally approximately proportional to the amount of impurity, and therefore may represent the relative danger of potable waters. A water that contains a large number of them should not be used for drinking without first being boiled. By boiling polluted water for half an hour all the infectious (but not the harmless) bacteria in it will be destroyed. If it is then filtered to remove the vegetable substances, and aerated to render it potable such water can be used with perfect safety for drinking. Since the infectious bacteria are the agents of all filth diseases, it should be the aim in all sanitary analysis of water to determine whether they have actual existence in the water, or what answers the same purpose, to determine the

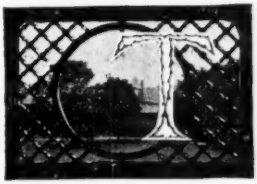
conditions favorable for their development. Whenever a chemical analysis reveals the presence of sewage in a water its use should be discontinued for drinking, without an expensive bacteriological examination.

In pleading for purer drinking-water we speak with a thorough conviction gained from the analysis and study of more than one thousand water supplies. But people may continue to drink impure water and still live, yet its continued use affects the human system and slowly degenerates our race. It can be shown that even slightly impure water is productive of a host of ailments for which the average sufferer finds no apparent cause. Public attention is now being directed not merely to cases where striking and violent effects are produced, but to all public and to many private water supplies: and investigations can now be made so cheaply by competent and responsible men, that the use of impure drinking-water is often a fault rather than a misfortune and continues more from carelessness and ignorance than from necessity.

Still it is often difficult to persuade those accustumed to polluted water to abandon it, since such water may have an agreeable taste and may have been used for years with seeming impunity. Many who are unacquainted with the etiology of disease cannot be convinced by the results of scientific investigation of the pollution of water and its terrible effects. They require the test of experience, and to some there is no test convincing of the pollution of water, except the actual production of sickness and death. But the scientific investigator recognizes the fact that diseases are now seldom produced by the agency of drinking-water that might not have been avoided by timely attention. These investigations force upon us the fact that as communities are supplied with purer water they not only enjoy a decrease in disease and death-rate, but they also often enjoy a most surprisingly rapid increase in thrift, morality and degree of civilization.

LANDSCAPE BEAUTY AT NEWPORT.

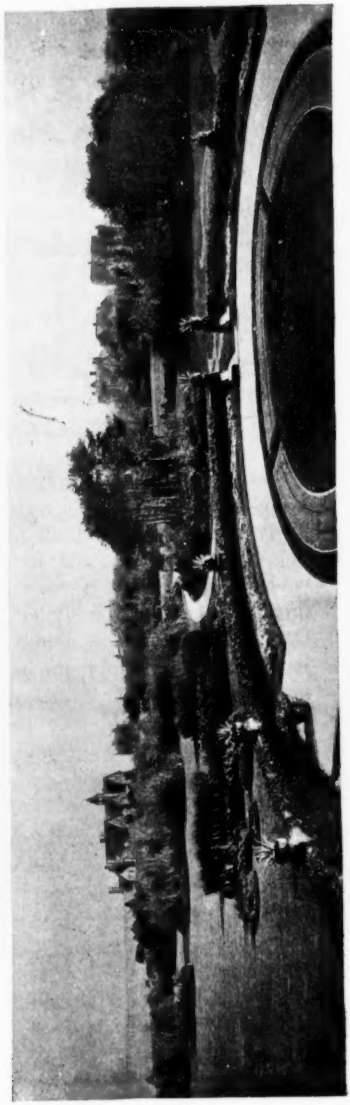
By John De Wolf, L. A.



THE glory of Newport is its ornamental grounds. Her noble ships and unmatched yachts sail to other waters winning trophies of war and races wherever they go; their pennants flutter in other air, their honors are distributed over the coast. Her splendid equipages and matchless horses roll and prance over other roads, but the lasting beauty of Newport still borders her avenues and crowns her sea-washed cliffs. Her fair women and distinguished men come and pass away, but her gardens abide with her from one generation to another. The gardens of Newport are new but the gardening art is old among her people—the love for it all but universal, and its influence most happily felt in giving character to the place.

In Colonial times it was in advance of the rest of America. Refinement and wealth early led to the adornment of the ground and the liberality of thought and action leading to the settlement of Rhode Island did not hamper her people with a belief in the sinfulness of delight in the fruit and flowers of this earth that oppressed some of their neighbors. The extensive commerce of early days brought to the port seeds and plants from many lands, refined and barbaric. Hawthorn hedges bloomed and sheltered Damask roses. The fair island of Aquidneck early became known as "the garden of New England," a title it worthily bears to this day. Of the earliest gardens nothing remains but the ground and tradition. Of those of somewhat later time the terraces and a few long-lived cedars still remain of Malbone's celebrated gardens; of Redwood's botanic garden not a tree is left, but at Vaucluse the waterfall still flows and glistens in the sunlight; the maze still has its representative, the summer-house and stone arches of the old pleasure-ground remain. The great September gales of 1815 and 1869 wrought havoc among the trees planted on the island, but worse than nature were the ravages of man, for during the war of the Revolution, when wood was the only fuel, the danger of going upon the unpro-

THE CLIFF WALK—NEWPORT.

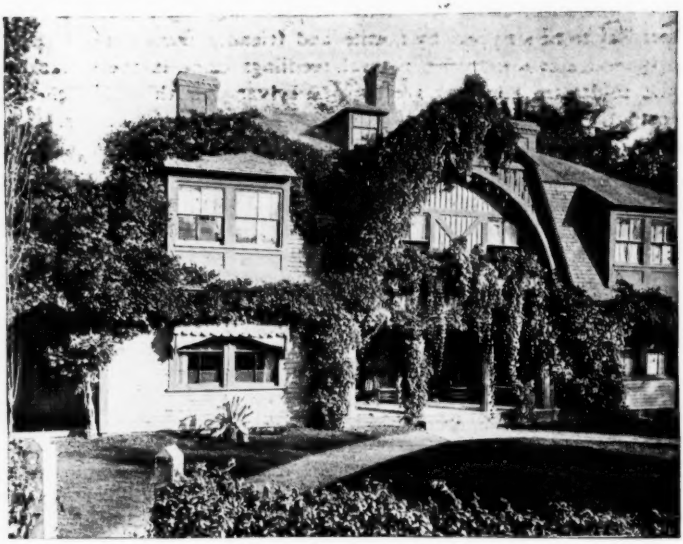


A GARDEN ON THE CLIFF

tected mainland caused the once well-wooded islands of Narragansett Bay to be stripped, by hostile and friendly fleets alike, of the last vestige of wood. No natural seedlings came in their places, and to-day these islands are bare of sylvan growth except where fostered by man. For this reason the grounds of Newport are especially instructive as showing what can be accomplished with skill and perseverance, under adverse conditions, for the winds are trying to young trees, and the warm air from over the Gulf stream, and the bright winter sunshine sometimes start the sap in unacclimated growth, only to perish with succeeding cold. By starting with trees, small in size and at first planted so thickly together as to afford needed protection, her landscape workers have now a display and variety that exceeds all other shores on the long Atlantic coast. In other places can be found single estates, finer, perhaps, than anything Newport has to show—larger and grander specimens of rare old trees—but nowhere such a succession of beautiful places for miles along the shore and drives—a sylvan and horticultural show unequalled, and replete with instruction for those who wish to improve their own surroundings.

The fascination of Newport gardens is in their variety. We do not feel that we have seen enough by having looked at a part. We rarely see a repetition of the same style even, and even so, the de-

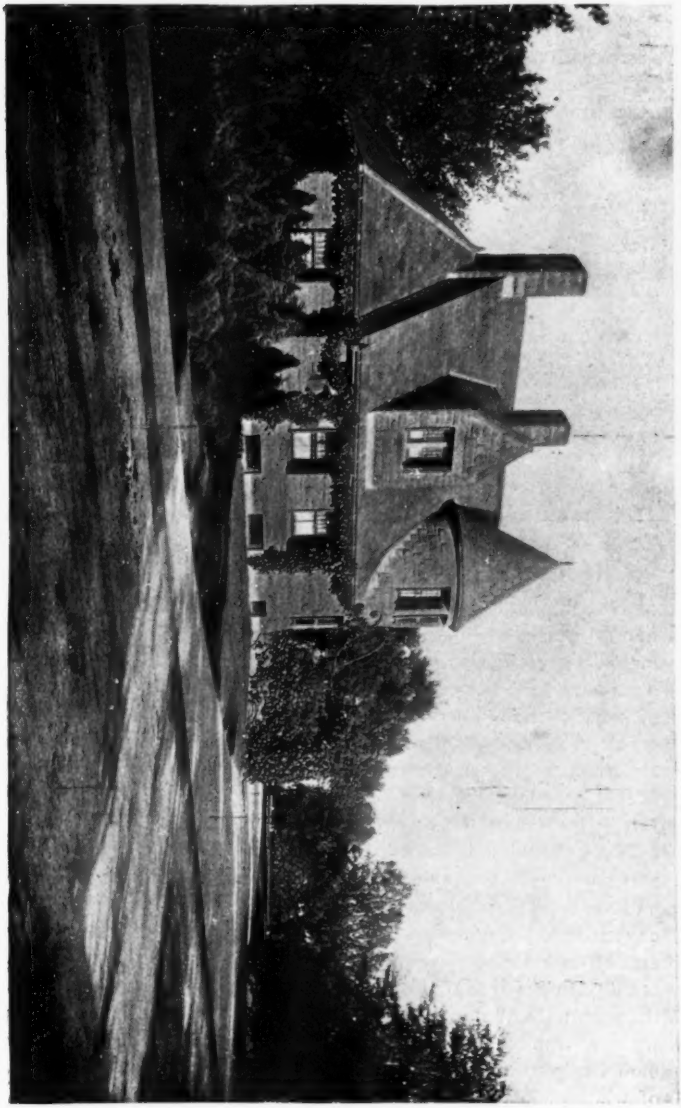
LOVE LANE, AT NEWPORT.



VINES ON A COTTAGE.

tails are so different as to give us another picture. It is not the work of one artist, whose work alone we see, but a grand exhibition of different designers and workers, whose originality has entered into their work, for the Newport gardener is a law unto himself, untrammeled by senseless rules, when his intelligence is large enough to grasp his opportunity and his mind expands under Rhode Island air and influences.

Good taste more than the variety of plants contributes to the beauty of these places. We may see defects it is true, but more to commend. We know not what most to admire: if we are in the older town we think nothing could exceed in beauty the huge trumpet creeper that half covers the gambrel roof of an old house or the mantle of woodbine that drapes another, with cool green during the heat of summer or warms it with scarlet in the chill of autumn, a plant that has made beautiful more unsightly places than any other, but when we see the Boston ivy covering the outside wall of a modern stone cottage and the sculpturesque leaves of the Dutchman's pipe mingling with the carving on the entrance porch, we must at least divide our admiration with them. Indeed the vines



LODGE AT "VINLAND" (CATHERINE LORILLARD WOLFE'S PLACE).

A NEWPORT PORTE-COCHERE.

of Newport are one of its most delightful features, growing in natural graces and profusion or carefully trained by the skill of man. They seem at home in nearly all situations, whatever may have been their native habitat. The English ivy covers the walls of some of the old stone churches, clothing them in a coat of perennial green and producing its clusters of greenish berries as if on British soil. The Japanese actinidia mingles most happily with the akebia, forming a background for the many large flowering clematis. But it is to attempt the impossible to try to describe all the beauty of Newport vines, and catalogue their varieties. The honeysuckles perfume the air as they cover walls and fences with trailing grace, and the wistarias and grapes scent the air in many sorts as they cover the rocks, houses or trees, as they do elsewhere, but nowhere else can we see the closely clinging euonymus used as it is here, and in all our catalogue of loveliness nothing could be more beautiful than a tall iron fence and gate, among the best examples of modern wrought-iron work around which twines a wreathing of the common virgin's bower, the black iron supporting the scattering masses of white buds and flowers in admirable relief.

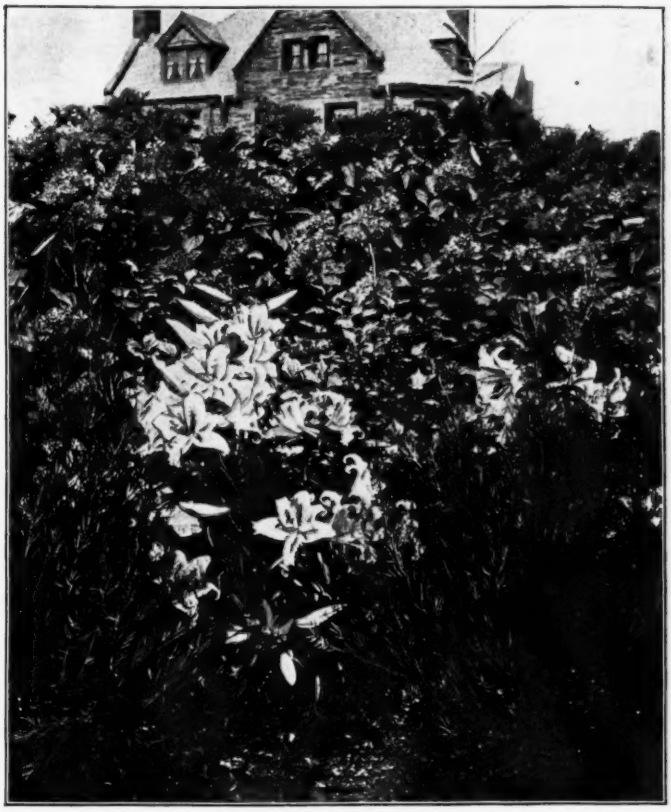
"THE BREAKERS."—CORNELIUS VANDERBILT'S SUMMER HOUSE.

The old town gardens have their charm and the most is often made of small lots. In no other city have the gardens so happily invaded the town ; yes, even the very houses, for floral decorations are said to be more common and finer than in any city in the world. On the busiest streets we fine little flowering spaces and decorations of potted shrubs, and the waters of the harbor show reflections of adjacent lawns, terraces and beds of flowers between the hulls of crack yachts and ocean flyers. Although the lilacs, hollyhocks and matrimony vines of the old gardens are so interesting, we must go to the modern part of the town where we will also find them with many other things.

GINKO TREE.

Let us take the famous cliff walk, for nowhere else in the world will we find so many useful object lessons, so delightfully spread before us. These grounds are all private places, but as the wise founders of this little State decreed that all comers should have the right of way to salt-water, we need no permission to cross them all.

This right of way has led to some curious manifestations of character on the part of owners, but most of them have sensibly built a good, well-drained walk for the use of pedestrians, generally following the bights of the cliffs, with a grand ocean view to the south and east, while inland we scan a gorgeous panorama of handsome places. Nothing pleases all alike more than the glorious expanse of the lawns unequalled, excepting by the blue ocean seen across them. Splendid as are the flowers and trees, the drives and buildings, we turn our eyes oftenest



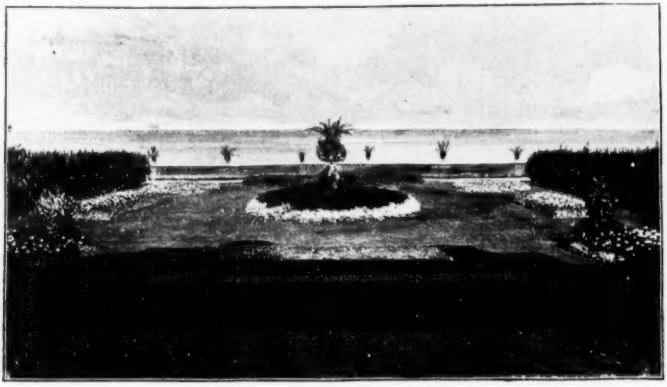
A BANK OF LILIES AND HYDRANGEAS.

to see their spreading slopes of green. Sometimes they are terraced, but most beautiful are those with gentle gradations connecting the different levels upon which the houses or buildings must stand. Sometimes rising near the boundaries with a living crown of shrubs they conceal some obtrusive object or falling gently away disclose a lovely vista seen from a lower level. Formed of the most common and insignificant of plants, the native grasses, most valuable of which is the Rhode Island fine-top, these

once barren cliffs have become a succession of lawns which that travelled nobleman, his Grace of Argyle, declared were the finest in the world. This use of common things is worthy of our closest attention. If we are surprised to see on the most costly estate a bed of cultivated thistles we cannot say they are misplaced, so admirably are they adapted to their surroundings. It is the same with a clump of golden-rod contrasted with the dark purple of our native asters. Here, where all is artificial, they seem perfectly in keeping and are not compared with the profusion of nature.

A RHODE ISLAND HYDRANGEA.

There is an absence of fences excepting an occasional stone wall, so screened by shrubs or hidden in vines that we hardly detect its presence, or a hedge that gives another interest to the scene. Even the public lanes and streets where they extend to



MRS. WILLIAM ASTOR'S GARDEN.

the cliffs are so happily planted about or hidden that they are not obtrusive. It is wonderful what skillful planting has done to give an air of space and extent to some of the smaller grounds. The outlines are arranged so as to show the largest available spaces, while shrubs and trees hide other places, giving such an interest to the spot by their color or form that we do not think beyond them. The massing and arrangement of the shrubbery is one of the most artistic features of this landscape work. Contrasts of color are admirably managed. Banks of the purple berberry or crimson leaf prune contrast with the golden spiræa or some billowy white

ROCKWOOD ON THE CLIFF.

flowering shrub-like Van Houte's spiræa. A dark fastigate yew shoots from behind a clump of golden retinospora or blue juniper. The scarlet sage seems to blaze with a more brilliant glow than usual, but it is the same flower so often seen in other places, only here we see it above the fresh green of the lawn ; among the dark leaves of the rhododendrons, or relieved in front of a great growth of hydrangeas.

The hydrangeas at Newport are a unique show in themselves. Nowhere else do they seem to thrive as in Rhode Island soil. The

"VINLAND"—CATHERINE LORILLARD WOLFE'S PLACE.

white grandifloras grow higher than the tallest man ; the more they are cut back the better they seem to bloom. They are seen to perfection on sloping banks and in such abundance that to some

MR. WHITING'S RESIDENCE.

tastes there were better less. Still finer are the old-fashioned blue and pink sorts which are grown in great clumps, producing clusters of sky-blue florets often a foot through, and so numerously as to hide their leaves. These old-style flowers with their great shows of bloom, of a color so rare among flowers that come during the heat and scarcity of summer, so noted in these gardens, attain their cerulean hue without especial care, although prone to turn pink on removal, in spite of treatment with chemicals and all the arguments that can be brought to bear. Here their roots easily survive the winters, and the tops with slight protection. Hedges are popular where a division or screen is wanted. The favorite hedge plant is the California privet, being sub-evergreen in this climate and standing sea-winds and changes well. The evergreens, oaks, and beeches are also used as hedge plants.

The beeches are favorite trees in Newport and there is hardly an estate with ornamental trees where a purple, weeping, copper or fern-leaved specimen cannot be found. Their great beauty, where they have attained any size, merits their popularity. Specimens with crested leaves and those with variegated foliage are also seen. One noble fern-leaved tree that grows conspicuously on the grounds of the Redwood library has so advertised them as to add considerably to the sales of nurserymen. There are beautiful examples of other trees, the ginko, cypress and weeping-oak, but not to single trees must we look, for our best instruction is in noting the way in which they are massed and grouped. Free use is made of the dwarf evergreens and the richness of form and color they reveal is unequalled by any of the bedding plants. Trees that will eventually become large are placed to allow for future development, but we hardly think the effect will be finer than at present. The intervening spaces are filled in with the depth and richness of color given by the evergreens, or the grace and life of a colony of waving tamarix, the plume-like delicacy of the retinosporas, the fascinating colors and spirit of the Japan maples are all displayed by giving enough of each to make a show. These happy effects are continued with hardy herbaceous perennials. The clumps of yuccas in the summer moonlight are beautiful as a dream, the lilies enough to make us all æsthetic poets.

The great carpet-beds are gorgeous with thousands of blazing alternantheras, coleus, oxalis and many other plants, but we soon tire of watching their unchanging glow. Marvellous triumphs of the gardener's skill, we turn from them to enjoy the changing but

unceasing beauty of the perennials, from the snowdrop and crocus in spring, arabis and moss pink, oriental poppies, iris of every hue pæonies, coreopsis and columbines, they keep up a grand procession through the season, with the magnificent delphiniums, funkias, hollyhocks, and all the long list of fall flowers, until the last anemone and chrysanthemum are frozen up for winter. Different owners have different tastes, therefore different gardens. We can enjoy tropical effects on many grounds. Groves of palm trees throw their shadows on the lawns in some places, and the great bananas spread their giant leaves above beds of heliotrope. No rose garden in America is more justly celebrated than the one of hardy roses so lovingly looked after by the historian Bancroft for so many years, and containing on our last visit just four thousand and one rose bushes.

The lily ponds and water gardens glow with a wealth of tropic color and add their splendor to illuminated fêtes and parties, with the night-blooming cereus and many nocturnal flowers. Orchids and tropic ferns there are, with ample glass houses to hold them, and for those to enjoy who like them, but these there are in other places, but nowhere else such ocean cliffs. Their treatment is different on various places ; nowhere so good as when left as Nature formed them. A few trailers and rock plants fringing the edge of the sward, or nestling in the crevices where their roots can find a holding place, show us that the beauty of alpine gardening is becoming known.

What a perfect foil the rugged cliffs afford for the polished grounds beyond ! Take away their rough surfaces and how commonplace the rest would be. Where they are walled up with broken stone and bare white mortar, how uninteresting they become, the grounds prison-like and as confined as Blackwell's Island. Why will people destroy fine rocks, often the chief beauty of their grounds that neither skill or money can restore ? It seems as if the best results follow by improving the things at hand, not striving for rare and tender botanical displays only to show our skill as gardeners. Botanical gardens want them for their students. Our home grounds want the beauty of health and vigor, of which there is more in a common pine, hemlock or well-grown maple, than in withering palms and stunted hollies. If we study in other places what can be wrought most finely with materials at command and vegetation that will flourish, we can have grounds like unto those of Newport, our peerless city by the sea.

THE CONDITIONS CAUSING A COLD-WAVE.

By T. Russell,

United States Weather Bureau.

THE term "cold-wave" applied to a sudden and great fall of temperature is a figure of speech. It is rather an avalanche of cold air that comes down upon the country. The essential idea in a wave is repetition. In the eastern part of the country there is a regular change in the temperature of the air of about fifteen degrees from day to night. In the high and dry regions beyond the Mississippi River the daily range is forty-five degrees in some places. The great irregular changes called cold-waves have no definite period.

The Weather Bureau definition of a cold-wave is a fall in temperature of twenty degrees or more in twenty-four hours, free of diurnal range, and extending over an area of at least 50,000 square miles of country, the temperature somewhere in the area going at least as low as 36°. Marking on a map where a cold-wave has occurred by lines through the places of equal fall of temperature the areas are seen to be enclosed and sometimes very great in extent. In one of the greatest cold-waves in recent years, that of February 17, 1883, the temperature at 7 A. M. was twenty degrees lower than at the same hour on the day preceding, throughout an area of 1,065,000 square miles, extending from Lake Superior and Georgian Bay on the north, to the Rio Grande on the south, and from Kansas City to Cincinnati. Inside of the area of twenty-degree fall there was an area of thirty-degree fall of 640,000 square miles; inside of the area of thirty-degree fall there was an area of forty-degree fall of 187,000 square miles; inside the forty-degree fall there was 31,000 square miles of fifty-degree fall, and inside of the fifty-degree fall, a fall of sixty degrees at Keokuk, Iowa, the centre of the cold-wave, the temperature which was 60° on the morning of February 16 being zero the next day.

The areas of temperature-fall occur first in the northwestern part of the country, and on successive days farther to the east, southeast or south. The great areas, 400,000 square miles or more, are tangent to each other on successive days. No areas, however large, ever overlap throughout a width of more than fifty miles of

country. The greatest fall of temperature at the centre of a cold-wave is different in different cases. In ten years there have been 2 cases with the falls at the centre greater than sixty degrees, the greatest being sixty-three at Moorhead, Minn., when the temperature fell on January 13, 1884, from 37° to —26° on the 14th. There have been 16 cases with the greatest fall between fifty and sixty degrees ; 77 between forty and fifty ; 248 between thirty and forty ; and 278 between twenty and thirty.

The area enclosed by the twenty-degree temperature-fall line is on the average about 900,000 square miles, when the greatest fall at the centre is about sixty degrees ; for forty degrees it is about 500,000 square miles. Sudden great falls of temperature are more frequent in the northwestern part of the country, beyond the Mississippi River, than in the east. They do, however, occur occasionally far to the east. At Boston, on January 26, 1831, the temperature fell fifty-five degrees in eighteen hours, from 56° to 1°.

The larger cold waves with areas of about 400,000 square miles within the twenty-degree temperature-fall line, with the temperature going as low as 20°, attract a good deal of attention at the time of occurrence. They are the topic of general conversation and newspaper comment. Cold-waves of smaller extent attract scarcely any attention, except in the case of some remarkable attendant circumstances, as deep snow or strong wind. The March blizzard of 1888 is remembered more for the great quantity of accompanying snow than the low temperature reached.

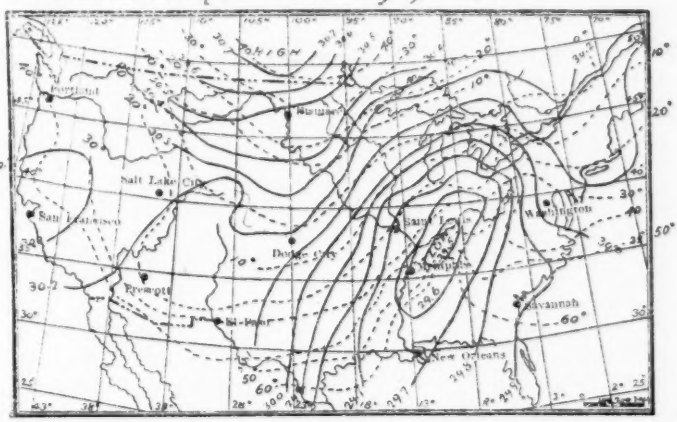
An opportune succession of cold-waves passing over the country causes severe winters. Some of these have been of such great public interest as to become celebrated. The winter of 1880–81 was severe. The temperature at Washington City, on January 1, was —12°. The winter of 1856–57 was very severe from South Carolina to Maine. The winter of 1834–35 was also severe. At Washington City the temperature on January 4 was —16°. Mercury froze at Bangor and Montpelier (—37°.9). On February 8 the temperature at Charleston, S. C., was 2°; at Athens, Ga., —10°, and at Cincinnati —18°. During the winter of 1779–80, in New England, there was no thaw for forty days, including March. It was long remembered as " the hard winter."

Since the establishment of the Weather Bureau cold-waves have an added element of interest for the public from the fact that it is possible to predict successfully most of the sudden and great falls of temperature twenty-four hours in advance. The object of

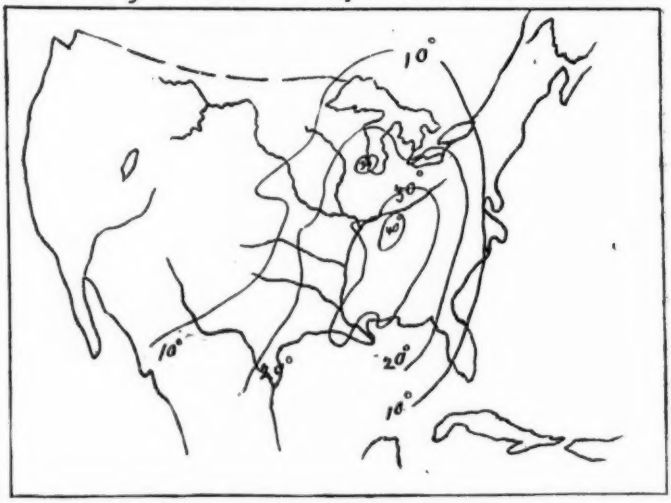
this paper is to give some account of the method of making these predictions. The weather-map based on observations made at about 150 places scattered over the country shows the condition of the air at the surface of the earth as to pressure and temperature over a region of more than 3,000,000 square miles of the earth's surface. The observations on which the weather-map is based are made twice a day, at 8 o'clock in the morning and evening. They are transmitted by telegraph to various places, and the map based on them issued three hours later in the principal cities. The pressure and temperature distribution is subject to the greatest diversity at different times.

A drawing herewith shows in miniature the weather-map of February 9, 1885. The condition of the air as to pressure is shown by lines drawn through the places of equal pressure reduced to sea-level. These are the full lines on the map and are called isobars. They are drawn for pressures one-tenth of an inch apart. Pressure of the air is expressed as height in inches of a column of mercury of equivalent weight. The average air-pressure is equal to about 30.0 inches of mercury. The dotted lines on the map are the lines joining points of equal temperature over the country, drawn for temperatures ten degrees apart. These are called isotherms. On the second map are the temperature-fall areas that followed on February 10, shown by lines through the places of equal falls of ten, twenty, thirty and forty degrees.

Weather Map, February 9th 1885.



February 10, 1885. **Temperature Fall Areas.**



There are characteristic features of pressure and temperature distributed over the country on the day preceding the occurrence of a cold-wave. There is always to be found an area of low-pressure with concentric isobars, or an area of high-pressure, or both a high and a low, the high-pressure to the north, northwest, west or southwest of the low. The low and high occur together on the map where the cold-wave is of greatest extent and the falls of temperature large. The isotherms where a cold-wave is about to occur show a rapid decrease of temperature from the vicinity of the centre of low-pressure towards the region of the high-pressure to the north or west of it, and have a characteristic trend running from southwest to northeast bending over in the vicinity of the centre of the low, usually to the east of it, then running more nearly east and even in some cases southeast or south. The decrease of temperature may be no more than thirty degrees or as great as one hundred degrees in a distance varying in different cases from 400 to 1400 miles.

At the centre of low-pressure the pressure may be as low as 28.9 inches in rare cases. On the average it is not lower than 29.6 inches. The severe forms of cold-waves may occur with pressures only a few tenths of an inch below thirty inches. The highest

pressure in a high-pressure area on the average is 30.5. In rare cases it is somewhat higher. The highest pressure ever observed in the United States was 31.1 inches in Montana.

The air moves from where the pressure is high to where it is low. For a difference of one inch in pressure in 1000 miles the accelerating force is the same as it would be for a particle on an inclined plane with a difference of about 900 feet in the elevation of the ends of the plane in the same distance. The winds in the region of an area of low-pressure blow around the centre in a direction contrary to the direction of motion of the hands of a watch held flat with the face uppermost. The direction is slightly inclined towards the centre. In a high-pressure area the winds blow out from the centre.

The upper currents of air over an area of low-pressure on the east side of the centre at a height of 5000 feet are out from the centre, the reverse of the direction at the ground. This is not certainly known. Over a region covered by low-pressure the sky is cloudy and usually there is rain or snow, so it is impossible to tell what the currents above really are. The upper current in a high area, northwest of a low, is in the same direction as at the ground throughout a great depth of the air as shown by the direction of motion of the high soprano-cirrus clouds seen at times at a great altitude. The high is a region where the air is very dry and the skies always clear.

The first idea that occurred to the writer when confronted with the problem of cold-wave predictions was to build a royal road for the purpose, by classifying and cataloguing the various weather-maps. It was conceived that if the whole series of weather-maps for twenty years past were searched it might be possible to find one exactly like any map under consideration in making predictions. If such a map could be found, then the weather that followed might be adopted as the prediction. There is such a great variety of pressure and temperature distribution that maps even distantly similar are very rare even with the record for twenty years, and the method is as yet impracticable.

Examination of the maps in a great many cases of cold-waves shows that the extent of a cold-wave is greater, the greater the extent and deeper the low-pressure area, the greater the extent of the high-pressure area, and the greater the contrast of temperature over the region covered by the high and low. Taking as the extent of a low, the product of the area by the deficiency of pressure below

30.0 inches and in the case of a high the product of the area covered multiplied by the excess of pressure above 30.0 inches, the unit of extent being taken as a deficiency or excess of one inch over an area of 100,000 square miles, the extent of different lows are found, from planimeter measurements of the areas between the isobars, to vary from a small fraction of a unit to a whole unit, and the extent of highs from a fraction of a unit to as much as ten units.

The extent of temperature-fall in a cold-wave can be graphically represented as a rough cone. The lines of equal temperature-fall on the map are intersections of planes with the cone; the line of zero change is the base; the amount of fall of temperature at the place of greatest fall is the altitude. The measurement of the areas between the temperature-fall lines affords the means of computing the extent of a cold-wave taking as the unit of extent a fall of ten degrees over an area of 100,000 square miles or twenty degrees over 50,000 square miles. On this basis different cold-waves vary in extent from one to thirty-three units.

From the discussion of a great many cases of cold-waves, with the most diverse size and distribution of low and high pressure areas preceding them, and with small and large contrast of temperature over the region, a formula has been derived for the extent of a cold-wave in terms of the extent of the high and low pressure. This was done by equating the extent of the cold-wave to the sum of three products, the extent of the high, the extent of the low, and the extent of the low into the isothermal gradient, each multiplied by an unknown fraction. The most probable values of the factors were derived from 120 cases by the method of least squares. This process has been measurably successful in disentangling and determining the numerical relation of the three principal conditions of the air, as shown by the weather-map, that go to produce a cold-wave.

The place of greatest temperature-fall in a cold-wave is at the place of highest temperature within a radius of 100 miles of the centre of the low pressure, or just in front to the east of the region of greatest temperature decrease toward the northwest, or at the turning point or crest of the isotherm of highest temperature. The true place of greatest fall will be, except in rare cases, within less than 100 miles of the place selected in this way.

The amount of fall at the place of greatest fall of temperature in a prospective cold-wave depends on the rapidity with which the temperature diminishes from the centre of the low-pressure area toward the northwest. The temperature, after the fall, is the

weighted mean temperature along a line from the place of greatest fall to the region of lowest temperature. The line being divided into sections by the isotherms through the region it crosses, and the temperature of each section being the mean of the bounding isotherms, the weights assigned to the mean temperature of each section are directly proportional to the lengths of the sections and inversely as the distances of the centres of the sections from the place of greatest fall. This rule applies when there is a gradient pressure over the region of at least 0.4 of an inch in 500 miles. The probable error for a fall of fifty degrees computed in this way is five degrees.

The shape of a temperature-fall area in most cases closely approximates an ellipse. The long axis is parallel to the long axis of the low-pressure area, or parallel to the isotherms south and west of the low centre. This direction is usually from southwest to northeast. In areas greater than 200,000 square miles the long axis of the area is 2.5 times the short one, for the case of the high-pressure area to the northwest of the low. For the high southwest of the low the long axis is 4.0 times the short one.

The method of prediction of cold-waves is then as follows: With the measured or estimated extents of the high and low pressures on a weather-map and the density of the isotherms, the extent of a prospective cold-wave is computed by the formula. The place of greatest prospective fall is selected and the amount of fall computed. From the relative position of the high and low-pressure areas, the ratio of the long to the short axis of the twenty-degree temperature-fall area is estimated. With the extent of the cold-wave, the contents of a cone, and with its altitude the greatest fall in temperature, from a table prepared beforehand, the area enclosed by the twenty-degree temperature-fall line is taken, considering the area to be an exact ellipse. By means of a previously-prepared cardboard pattern of the proper shape and of a size adapted to the scale of the map, the outline of the temperature-fall area is marked on the map. The thirty-degree and forty-degree temperature-fall lines are sketched in between the twenty-degree fall and the place of greatest fall. Thus the region is known where the cold-wave is about to occur and the temperatures which are to be expected. Warnings are telegraphed to places interested.

This method of predicting involves scarcely any theory. The equation adopted is practically an assumption that the displacement of air over a cold-wave region is in a measure proportional to

the circulation induced by the greater or less extent of the low and high-pressure areas, and that the amount of fall is due to the contrast of temperature over the region. A certain condition of the air is seen to be followed by a certain other condition of temperature. The special cases establish the numerical relation between the conditions for the average of the cases.

Not in all cases, however, do falls of temperature follow after areas of low pressure. At Chicago on March 4, 1881, there was a pressure of 29.4 inches and a temperature of 20°, with a temperature of—6° in Manitoba and a pressure of 30.4 inches. According to what usually occurs, a large fall of temperature was to be expected at Chicago, but instead there was a rise of 6 degrees. Cases of this kind occur occasionally, the reasons for which are not known. The failures of cold-wave predictions result from cases of this kind, and from attempting to predict the smaller cold-waves of less than 100,000 square miles in extent, the areas of which cannot be accurately located. The extensive cold-waves with great falls of temperature can be successfully predicted in most cases.

A theoretical treatment of the motions of the air involved in cold-wave production is entirely out of the question in the present state of the science of physics. The areas of high and low pressure that traverse the earth are probably connected in some way, as yet unknown, with the general circulation of the whole atmosphere. At the equator the air is heated more than at the pole and being expanded is raised higher in level in the upper layers. There is a continual flow of the upper air from the equator towards the poles, deflected to the right by the rotation of the earth.

In the northern hemisphere outside of the zone of trade-winds there is a general motion of the air from west to east around the earth, resulting in a more or less permanent area of low pressure over the north Atlantic Ocean. In this region there are three centres where the low pressures are variously developed at different times; one near Davis Straits, longitude 60 degrees west; one south of Iceland 20 degrees west, and the other near the White Sea north of Russia 40 degrees east. The greater or less development of low-pressure area near these places in winter has an important bearing on the occurrence of cold weather in Europe. Low temperatures occur differently in Europe and the United States. In Europe the change mostly advances from the east toward the west and is slow and gradual. In the United States the change is almost always from the north and west towards the south and east.

CIVIL ENGINEERING.

"THE First Bridge over the Mississippi" was the introductory phrase of a paragraph printed upon page 101 in the October issue of this magazine. It was based upon a paper read before the Engineering Society of Minneapolis, and contained a criticism upon the bridge, and an account of its demolition. The engineer who erected the bridge, Mr. Thomas M. Griffith, now residing in New York City, has, in a letter addressed to the editor, taken an exception to the criticism, and has made a counter-criticism of the method employed for taking down the bridge. In his letter he says: "I was engaged by a few enterprising gentlemen of the Territory of Minnesota, in the year 1854, to build a suspension bridge across the Mississippi at the town of St. Anthony. The land on the west side of the river was, at that time, within the military reservation of Fort Snelling; and the bridge was the first which was ever erected across the Mississippi River. The Railroad Bridge at Rock Island was, however, then in course of construction. On the completion of the bridge, Gov. H. H. Sibley—later Gen. Sibley—on the part of the Bridge Company, of which he was president, presented the engineer with a liberal and handsome testimonial, expressing the entire satisfaction of the Company with the work. When the charter of the Bridge Company expired the bridge became the property of Hennepin County, and, finally, of the City of Minneapolis. It was a light bridge, not suited to the traffic of the rapidly growing city. In 1875 I was called upon to replace it by a larger and stronger bridge. I took a professional pride in executing this work, and endeavored to do the very best for the money the City Council was willing to put into it; and I claim that my designs were all good, and could not be very much improved upon now. But I was working for a city having aldermen and politicians for its agents; some of them were very good men, but some of them were not; and their enthusiastic interference with the methods and the work of the engineer increased his anxiety and labor and deteriorated the result. The masonry was not as good as it ought to have been; the cable laying was not so accurate as I had hoped to make it; and the faulty "covering-in" of the cable-end (done because the Council deemed it expedient from motives of economy, and after I had ceased official connection with the work) was the cause of the rusting off of strands of wire. The character of this work may be determined by those interested, without trespassing upon your space, by a reference to *Van Nostrand's Magazine* of March, 1878, in which it is fully described. I presume that other engineers and contractors have had experiences which do not widely diverge from mine in the construction of this bridge, and that they can therefore appreciate my position under the circumstances. Some of them have fared better, and others worse than I did, but I can positively assert that none had a more infinitesimal 'pull' than I had with that body of Minneapolis statesmen. The proper way to have taken the cables down, would have been to have exactly reversed the process of laying them up. First, all of the wrapping should have been stripped off; then the end-thimbles should have been freed by releasing the outside linkbars; and thereupon each wire could have been reeled in reverse order to that in which it was run out, thus saving time and material, and reducing the cost of demolition below the figures named by Mr. Cappelen." As Mr. Cappelen's criticism was rather severe upon the bridge, we have thought it but just that its constructor, Mr. Griffith, should have his "day in court."

A New Railway Sand and Snow Fence has been invented by Mr. W. L. Howie, of Cornbrook House, Eccles, near Manchester, England. The invention involves an entirely new principle in keeping tracks clear from sand and snow. Instead of, as

heretofore, being interposed to stop the passage of sand or snow, it affords a free sweep of the wind over the rails with such force and in such a direction as to carry the snow along beyond the track, instead of depositing it thereon. This is accomplished by two deflectors, one on each side of the track, each placed in such a position that it extends not only to some considerable distance above the upper line of the embankment, but also to a distance below this line on the inner side of the embankment, and inclined at an angle very nearly the same, but a little more acute than that of the embankment itself. The wind, striking either of these deflectors, is directed downward toward the track along the slope of the embankment, and, nearing the bottom, its direction is changed into a curve of very large radius so that it passes almost horizontally across the track. Thence it is directed upward along the other embankment and under the opposite deflector, carrying with it the snow or sand as the case may be, and, it is claimed, completely clearing the rails. On the windward slope the snow accumulates and gradually projects over the open cut. If the track be double, that on the lee side will be kept almost clear of snow, even during a long storm. It is stated, however, that the second track will be somewhat obstructed. *Engineering* (London) says that this fence was erected on trial several years ago near Halkirk, England, and has, so far, seemed efficient; although that journal thinks that since the erection of the fence there has been no storm severe enough "to test its full capabilities."

Of Railway Progress in Japan, that prospective seat of a high oriental civilization, some interesting figures have been given in a recent number of *Industries* (London). Two lines of railways already exist in the Hokkaido. One of these is a single track of 3 feet, 6 inch gauge, completed in 1887, and running from Sulphur Mines at Atosanobori to Shibechi, a distance of 25 miles, whence to Kushiro, a port of shipment 44 miles further, there is water conveyance with which the railroad connects. A second line is from Otaru, a port on the west coast, to Sapporo, and thence to coal mines at Poronai, a distance of 55 miles, with a short spur, 7 miles in length, which connects the road with the coal mines at Ikushunbetsu. This railway was constructed by the government and leased in 1886 to a private lessee, passing in 1889 into the possession of the Hokkaido Mining and Railway Company, when this company was organized. A new line is now in process of construction which will connect the coal mines in the northern part of Sorachi in the Ishikari district to Mororam, a port on the southeast of the island and the northeast point of Volcano Bay, a distance of 143 miles. One section of 33 miles of this road is already completed. A further extension of the road is also contemplated, by which it will be run into the very heart of the island, where is to be erected an imperial palace, and in which it is intended to establish extensive colonies.

The Deterioration of Water-Works Plants is a question which has been recently raised by proceedings before a Supreme Court commission held in Syracuse, New York, to determine the value of the plant of the Syracuse Water Company. This question is discussed ably and at length in a recent number of *Fire and Water*. The estimation of such deterioration is shown by this article to be impossible without a preliminary "rigid examination and investigation" of the various constructions comprised in the work, and a careful consideration of "the influences that have been active in producing the deterioration." The writer of the article takes the position that reservoirs, earth embankments and properly constructed masonry are less liable to deterioration than any other constructions in a water-works plant. Anything which is a part of the machinery for operating works, as boilers, pumps, engines, etc., as well as those which partake somewhat of the character of machines, as gate-valves and fire-hydrants, will be subject to deterioration in proportion as their use is more or less constant. As for cast-iron water pipes, "the quality of iron, method of casting and coating processes are associated with its ability to perform its work;" but such pipe

"has been in use for over fifty years in the United States." The life of iron pipes is, however, affected by the character of the water, as to whether it is hard or soft, and also by the "character of soil or earth in which the pipe is laid." Then the writer goes on to point out that as "hardly two cases are exactly alike" and as the "skill of the engineer or superintendent in charge" is also a factor in the durability of water works, considerable margin remains for the exercise of sound judgment in making an estimation of their deterioration.

A New Kind of Railroad which can be cheaply constructed and which is sufficiently strong and durable for use in timber-lands for getting out logs, or for use in mines in transporting coal, ores or refuse, has been invented by Mr. John N. Valley, of Jersey City, N. J. It has a single rail-track supported by hangers from longitudinal stringers, sustained by straddled posts or struts, the tops of which are joined to opposite sides of the stringer by bolts. Where curves are necessary the ends of the stringer-sections are connected by means of links and bolts; but in the straight portions of the road the ends of the stringers are simply rabbeted and bolted together. The rail is of timber, the hangers passing from the stringer down through the middle of the rail, and the track consisting of the parallel outer edges of the top of the rail, respectively on each side of the hangers. On this rail run 4-wheeled trucks, and the load, which may be a log or a number of logs joined together, is suspended from the frame of the truck and is borne along beneath the rail. The motive power may be a cable; or the traction may be effected by horses or mules. A special form of brake which bears against the bottom and side of the timber rail is provided. The road described herein is stated to admit of modifications which have been covered by several distinct patents, which modifications adapt it to the varying character of different locations and to different kinds of service.

A New Scheme for the Disposal of Sewage and Garbage has been proposed by an English engineer, Mr. E. R. Shapland. The method is based upon a daily collection of all the garbage of the London metropolis. This is to be carted and thrown into deep trenches, after bricks, bottles, stones, earthenware, etc., have been sorted out. Upon the deposit of garbage is to be pumped or thrown the sewage, this process to be repeated, day after day, until the trenches are filled. The surface is then to be covered with gypsum as a preventive of the escape of effluvia. The trenches are then to be filled and nature left to do her work through fermentation and other chemical processes until the whole is converted into a harmless and inoffensive fertilizer. It appears to us that the question of the time which would be required to effect this change is an element of difficulty which has not perhaps been sufficiently considered. Under the conditions proposed this change would not be completely effected in less than from eighteen months to two years. Taking the lower limit of time as a basis for computation, there would be needed 552 trenches, each of a capacity to contain all the garbage and sewage of London for a single day. It will be seen that a pretty large area would be required for a dumping ground. However, this may be a difficulty more easily surmounted than may, perhaps, seem possible at first sight. It also appears that the system merely creates a gigantic cesspool the effects of which might be no less to be dreaded than those of more numerous, smaller cesspools.

A Wrecking Tug, Working upon a Novel Principle, has been brought out by a coast-wrecking corporation of New Bedford, Mass. The prominent features of this tug are a steam windlass winding up a 2-inch chain, and a steam capstan for using heavy hawsers. In operation a very heavy anchor is thrown out, and the chain and hawser being drawn taut, the swell of the water on the bottom of the tug acts as a force for pulling off a stranded vessel. The engines, of course, take up all that can be gained as fast as it is gained. It will be perceived that this action is very much like that of pulling laterally upon the middle of a long cord, attached at one end to a fixed support and at the other to an ob-

ject to be moved, the strain upon the support tending to draw them toward each other being immensely greater than that of the static force of the pull applied. According to the principle of virtual velocities, the static force of the swell upon the bottom of the tug multiplied into the distance it is raised by the action of the water will be equal to the much greater pull upon the stranded vessel multiplied into the much shorter distance through which the vessel is moved. This action being based upon a sound principle, we predict that the new wrecking-tug will prove a success.

A New Hose-Bridge is the name of a very effective invention which has been invented by Mr. Charles Nagl, Superintendent of the West Side Cable Road in Chicago, and which appears to be an entirely competent arrangement to prevent the obstruction of street railways in case of fires in cities wherein it is necessary to cross a railway track with fire-hose. The whole apparatus is so extremely simple as to render it surprising that it has not been sooner thought of. The invention is described and illustrated in the *Street Railway Review*, but a good idea can be obtained without illustration. The whole bridge for a double track, can be erected or taken down in four minutes' time by the labor of six men and a foreman, and it consists of three portable trestles 13 feet in height and set 7½ feet apart. The hose is run up and over these trestles so that the street cars pass directly under it. Three sets of hose may be passed over a single bridge. The Company keep this bridge in a building mounted upon a wagon after the manner in which hooks and ladders and similar fire apparatus are mounted in fire departments. They have also an electrical arrangement by which, whenever a fire signal is sounded in a part of the city wherein it may affect the running of their cars, the signal is repeated in the company's barn. A special crew, which at other times is employed at other work, is then immediately detailed to attach horses to the wagon and make the run to the point at which interference may occur. The wagon carries three sets of bridges.

As Regards the Use of Torpedoes in Naval Warfare, a correspondent of the London *Times* points out a cause which must affect the full efficiency of any torpedo, no matter how well it may be constructed, or how well adapted to the purposes of attack or defense. This is "the flurry and excitement" of what Mr. Depew has aptly styled the 'human element' that manipulates the torpedo. A nervousness, which, even in peace manœuvres interferes with efficiency, is much more liable to attack an officer or man in actual service. "In his agitation he forgets to do something that is essential, and so his torpedo fails to run. Or, if he do not forget anything that is essential in the preparatory part of his duty, his excitement gets the better of him at the moment of firing, and he unduly hurries or delays to press the firing key." The writer estimates that more than half the failures and misses of recent torpedo operations are due to this cause; and it will be apparent that it will be proportionally more or less effective as the mechanism of torpedoes is more or less complicated.

The Slide Rule, by William Cox, New York, is a recently published and a very practical treatise illustrating the application of the slide rule to the solution of problems which daily occur in the practice of the merchant, importer, spinner, manufacturer, engineer and architect. An introduction is followed by a description of the Mannheim slide rule with directions how to use it for multiplication, division and proportion; directions for determining the position of the decimal point; methods of using it for determining squares and square roots and for performing trigonometrical computations; tables of equivalents for scales; methods of working out mechanical and other formulæ; for computing compound interest; for determining data for rope driving; weights of metals, either in bars or in the form of pipes; safe load on chains; horse power required for pumps; discharge from pipes when real velocity is known, etc. It is a very neatly printed and valuable little work. The publishers are Keuffel & Esser, New York.

ARCHITECTURE.

MODERN Home Heating is discussed by a writer in the *International Journal of Surgery*, who professes to be in the interest of no heating appliances whatever. In the main, his statement with regard to the relative merits of different sysems of heating is a good one. He would have no house absolutely destitute of open fireplaces; rather he would have each house supplied with a number of these, considering them as ornaments and as aids to ventilation. He regards them, however, as entirely inadequate for house heating. Stoves are dirty things, requiring a large amount of care and permitting occasional escape of coal gas. Add to this that they take up unnecessary room and must be taken down and put up twice a year. He thinks that houses may be "heated, but not really warmed, with stoves." Furnaces, he thinks, furnish "a fairly good method of house heating, being easy to take care of" and "throwing off a generous amount of heat if one burns enough coal." Generally, however, a furnace leaves one-third of a house unheated. The writer professes that he has never known a furnace that "did not generate and freely disperse coal gas before it was three months old." The registers of furnaces are also a fruitful source of dust and dirt. He states that air-boxes universally allow of the intermingling of the cellar air with the air delivered to apartments from furnaces; but this should not be the case, if the cold-air-boxes are properly made and connected with the furnace. As to hot-water and steam-heating he decidedly prefers hot water, his preference being based on his experience with hot-water heating in his house and steam-heating in his office. Moreover, he prefers the direct system to the indirect, not on account of any objection to the indirect system, except that it is less economical than the direct system, but because he thinks the direct system is equally as good. We are obliged to take issue with him on this point. The direct system is open to the objection, that unless ventilation is carried out by fireplaces, which if done well necessitates a fire in each fireplace, it will rarely afford an adequate ventilation. The indirect system does this perfectly, if ventilating flues be properly constructed and arranged in the building. However, the indirect system is admittedly more expensive, both in first cost and in the use of fuel, than the direct system, and as a house wholly heated by the indirect system is generally over-ventilated, the true method appears to us to be a compromise between the indirect and the direct systems by heating only the lower floors by indirect radiators, while direct radiators are used in all other parts of the building. The direct-indirect method may also be employed to advantage in many buildings for purposes of ventilation, although we should not approve its sole use for domestic heating.

The Utilization of Waste Glass for Architectural Purposes has been initiated by three French inventors, Messrs. Rostaing, Garchey and Geille. In the application of this process as described in *Invention* (London), any fragments of broken glass of various colors are mixed together, after having been broken to a suitable size; they are then placed in moulds lined with silica, talc, or some other resisting material and fired. A coherent mass is produced which can be dressed and cut into blocks, which are, of course, irregularly colored. Such blocks may be used as artificial marble. The blocks are usually rough on one side, owing perhaps to incomplete fusion; this gives a surface which is admirably adapted for causing them, especially if they are slab-like in form, to adhere to walls with the addition of a little mortar. Fine decorative effects can thus be produced. Designs in relief can be ob-

tained by pressure while the block or slab is still plastic. If a suitable mould be prepared with movable partitions, then pieces of glass can be arranged in such a way that, upon firing, a very effective "stained glass" window is produced, the necessity of using "leading," as in the ordinary way, being thus obviated.

The Ventilation of Buildings, by Alfred R. Wolf, M. E., is the title of a recently published pamphlet containing an essay on the general principles of ventilation, with formulæ for determining the quantity of air to be supplied to the inmates of rooms to dilute the air to a desired standard of purity. The results of these formulæ are tabulated; so that by knowing the number of cubic feet of space in the room per individual, the amount of air necessary to be supplied to give different degrees of dilution may be at once taken off. Formulæ for the draught of air in vertical vent-ducts are also supplied, together with a table showing the quantity of air in cubic feet discharged per minute through a ventilating duct having a cross-sectional area of one square foot, the external temperature of air being 32° F. Other useful tables are comprised in the treatise. The author of the pamphlet was the designer of the system of heating and ventilation adopted in the new building of the Mendelssohn Glee Club, noticed in the August number of this magazine in the Department of Architecture; and he is also the Superintendent of the installation of that plant. Being an expert in this line the information given by him is reliable and valuable.

A New Substitute for Glass is the invention of Friederich Eckstein, of Vienna, Austria. In the specification of his patent he states that the substance is produced by dissolving four to eight parts of collodion-wool (gun-cotton) in about one hundred parts by weight of ether, alcohol or acetic ether, and intimately combining two to four per cent. of castor oil or other non-resinous oil and four to ten per cent. of resin or Canada balsam. Any other balsam of a similar nature may be substituted for the Canada balsam. The compound, when poured upon a glass plate and dried in a current of a air at a temperature of about 50° C., solidifies into a transparent glass-like sheet or plate. He states that the sheet or plate so obtained has the same diaphanous properties as glass; that it will resist the action of salts, alkalies and dilute acids, and that it is devoid of smell. It is pliable and is broken with great difficulty. Its inflammability is less than that of transparent collodion sheets. Any desired color or shade of color may be imparted to the substance by the introduction of proper materials. Transparent colors may also be applied to the surface—aniline colors being most suitable for this purpose. In this way the plates may be prepared as a substitute for stained glass in windows. The surface may be also ornamented by a printing process. The introduction of grape sugar or magnesium chloride into the composition of the material reduces its inflammability. The addition of zincite or heavy spar gives it the appearance of ivory. By varying the proportions of castor oil and resin the material may be given the toughness and pliability of leather. The inventor claims that the material is also suitable for the manufacture of tableware and for many other purposes.

The Finishing of Soft and Hard Wood Floors is the subject of an excellent article recently published in *House Painting*. As to soft wood floors, as those of white pine, the journal quoted states that a very different system of painting is required for them than that employed in other parts of the building. Paint, as ordinarily mixed, stands very little wear when used on floors, and at least a yearly re-painting is necessary to cover up bald spots. Floors should be laid very carefully, the tongue and grooves having a coating of thick lead before joining. The floor must be perfectly dry before applying the priming. Very great stress is laid upon this, as it is asserted that no subsequent amount of painting will last unless this condition be observed. Any kind of pigment may be used in the priming so long as the vehicle is good, sound, raw linseed oil; but it is essential that the pigment be finely ground and well brushed in and out. Only a con-

scientious, perfectly reliable man can be depended upon to apply the priming properly. The journal quoted states very forcibly that "simply hiding the bare wood from sight with paint is not priming." Floors should be painted only with hard, durable paints. Those of lead or zinc, as earth colors, will not stand wear long. The lead oxides are the best,—as, red lead or litharge,—and either one or the other of these should become the base of the paint. The range of shades will not be very great, but it is possible to vary the shades to harmonize with other painting in the building, and by tinting with other pigments, shades of brown, buff, grays and drabs in quite a variety may be obtained. Two coats at least of these paints should be applied to the priming, and it is asserted that they will dry and become as hard as, or harder than metallic lead, and that they will not crack. For hard wood floors the article referred to names a number of compositions in the market as being mostly only varnishes of good quality. A serious objection to them is that they wear through, or darken, and that it is impossible to repair them over worn places without showing patches. As a conclusion, the only finish considered as fit for hard wood floors is wax. This preserves the tone of the wood and even enhances it, and, when worn off, a very short time suffices for the invisible repair of the worn spots.

A New Feature of Instruction at Columbia College is the readjustment of the courses of study in the Architectural Department under charge of Professor Ware. Work previously requiring four years has been compressed into three years by dropping some comparatively unimportant studies in the first year and placing the historical studies one year back. Under the present arrangement the elementary architectural studies, as well as the general studies, will be finished by the end of the third year. A number of more advanced studies will be taken up in the fourth year, as in history, construction and design. In order to avoid crowding the fourth course too much, these studies are made elective, and the tendency to specialized work will be promoted by the elective character of the course. If desired, a five-year course, including studies which were omitted from the four-year course in order to make room for the elective studies, may be pursued, thus harmonizing with the university idea which is the present tendency of the Columbia College policy.

The Use of Electric Elevators in Buildings is gradually increasing. There are many economies and conveniences in their use as well as some remaining defects, but they are undoubtedly here to stay, and the usual improvements following upon new inventions may be expected to remove largely some objections which yet attend their use. In this connection the thought suggests itself that electricity might be employed in architectural construction to a greater extent than it is at present. Its uses for opening doors and for operating bells are familar to most people. There seems no reason why it could not be applied to the opening and closing of windows, the raising and lowering of window blinds, the operation of window shutters, sky-lights and transoms, as well as for the purposes to which it has laready been adapted.

A New Oil or Vehicle for Paints, to which has been given the trade-name of "Lucol," has lately been placed on the market by a San Francisco manufacturing company, the vice-president of which has made several addresses to the Chapter of Architects, the Technical Society, and the Master Painters of that city, setting forth the merits and advantages of the new oil. The *California Architect and Building News* has collated from these addresses some twenty or more points of superiority claimed for this vehicle as compared with linseed oil. These are: A good and clear color; a not disagreeable smell; permanence; a good body; quick or slow drying, as desired, through the use of certain light solvents; good "holding-up" quality; good "bearing-out" quality; the property of drying hard or soft, as desired, according to its manipulation; good adhering quality; adaptation for use with a variety of "thinners"; entire absence of any action on the tints of even the most delicate colors; ready admixture with any other

pigment; a fine gloss if not used too thinly; a longer retention of tints than is possible with linseed oil; economy in pigments, as less is required to the gallon than when others oils are used; free "spreading"; less liability to blister than linseed oil; elasticity, preventing cracking; resistance to the action of alkalies or caustic lyes used for washing; greater durability; never "chalking" or peeling off; flattening when desired by the addition of "thinners." This is a long list of good qualities and if the claims can be fully substantiated in practice, Lucol has a future.

With Reference to the Modern Office-Building, meaning by this the tall buildings which are so marked a feature of present architecture, Mr. Adler of Chicago, quoted by the *Architect and Building News* as a man of large experience in this class of structures, points out a danger arising from their close proximity. This is stated by Mr. Adler as follows: "The construction of the adjacent building will increase the load per square foot of foundation area from 3500 pounds to 4220 pounds, sufficient to induce, as I have myself observed, an increase of settlement on the part of the already existing structure of from four to six inches. This would probably become somewhat greater at the front and rear walls where there would also be the additional load of the corner pier and half the fillings between the nearest openings."

Toy-Block Architecture seems the most suitable name for a species of design which appears to have originated in Chicago, and of which the accompanying diagram will give an idea. This is the immense new Odd Fellows Hall, noticed in our October number. If such hideous structures as these are to come into vogue one would almost wish that the utilitarianism of the present age could be replaced by mediævalism. It is as though a child with an assortment of toy blocks had erected such a structure as the fancy of the moment suggested. Since writing the above criticism it has been emphasized by the erection in one of the show-windows of a dry goods store in New York City of a miniature imitation of the much-trumpeted Pulitzer Building, the model so produced having been made wholly out of spools of thread of uniform size. We must admit that the imitation was perfect, and that the ingenuity of the spool architect deserves to rank among the best of the toy-block achievements. The New York *World* printed in one of its issues an engraving of the spool-building, and seemed rather proud of the performance. No doubt the builder of spools will now consider himself a full-fledged architect, and his services would be desirable in designing other toy-block buildings for the adornment and glory of New York and Chicago.

"Picturesque Railroad Stations," contributed to our present number by Mr. Bradford Lee Gilbert, suggests that railway architecture is making greater artistic advancement than might be thought by some as corresponding with its utilitarian character; but true art is never out of place. A notable example is the new terminus of the Philadelphia and Reading Railway in Philadelphia, in which a beautiful design in pink granite, brick and terra cotta form an admirable façade.

ELECTRICITY.

THE Progress of Modern Invention is hailed by Dr. DeWitt Talmage as furnishing means for the propagation of the Gospel, which he expects to be of great and immediate service. Particularly he believes the *phonograph* to be the great instrument in carrying the Word into heathen lands. He may be right. The phonograph, without danger of malaria, could enter into many regions now dangerous to the health of Europeans, and in cases where a missionary might be liable to be eaten, a phonograph, not being edible, might be considered as eligible. Dr. Talmage exclaims:

"Send 500 lectures to out-of-the-way places in China and see that a phonographic translation of that bright discourse against Buddhism is sent out to India, you will see the possibilities. Then our missionary scholars can do their work surrounded by civilization and supported by the best of God's ozone. Now the climate and the hardships of life kill hundreds. Then we can have a thousand men where we have one now, and one sermon can travel from one end of a country to the other and preach its mission to millions."

We think, however, that one of the Doctor's sermons would lose much in force in its repetition by a phonograph, owing to the lack of the characteristic gesticulation with which he is wont to emphasize his arguments. An electric gesticulating and posturing device is thus seen to be the great missionary want of the present time.

The Editorship of *Electricity* (Chicago), one of the newest and brightest of the electrical journals, has passed, through the illness of its original editor, into the hands of Mr. Herbert Laws Webb, than whom it would be difficult to conceive a better selection. Mr. Webb is an able writer on electrical subjects, being possessed of a literary skill not often found among those who are otherwise highly qualified for such positions through their scientific and practical attainments. If he can work untrammeled in his new field, it will not be long before he will place *Electricity* in the first rank of electrical journalism.

"A Note on Telephone Formulæ" is the title of an interesting article published by Mr. Herbert Laws Webb, in a recent number of *Electricity*. In this article he claims that the formula given by Professor Jacques of Boston, some years ago, to the effect that "good speaking was possible with a Blake transmitter when the product of the total capacity of the line, in microfarads, into its total resistance in ohms, fell within the number 2500," and the subsequent raising of this product to 4000, upon the appearance of the Hunning's transmitter, more powerful than the Blake, "have long been exceeded in ordinary everyday practice; therefore Professor Jacques' formula may be considered to have been based on a too conservative estimate." He quotes the formula given by Mr. Preece, the chief electrician of the British Postal Telegraphs, as setting "a limit for good transmission at least twice as high as the highest given by Professor Jacques." After noting some of the causes for the reduction of what he aptly terms "telephonic energy," both in overhead wires and underground cables, and working out the distance to which telephonic transmission is possible through such cables on the basis of a product of 8000—which is considered as a safe limit—he arrives at the conclusion that it is "possible to speak through 53.5 miles of cable insulated partly by air spaces, as against 33.8 miles of the older types of cables."

As to the use of the Three-Phase Current in the Lauffen-Frankfort Transmission, Mr. C. E. L. Brown writes to the *Electrical World* (New York), "that the principal object of the experiments was to prove the possibility of producing and transmitting high-tension currents over

long distances by naked wires suspended from poles, and with such a degree of security against danger, and such a small amount of loss by leakage, as to demonstrate that this mode has commercially a right to exist." The idea originated with him, as he states, at Oerlikon, in experiments made there; and this, in connection with a lecture delivered by him at Frankfort on the 9th of February, 1891, determined him to carry out the "Lauffen-Frankfort installation as it now exists." Mr. Brown took the position in his lecture that "currents of 20,000 volts or more could be carried by naked wires suspended from poles on suitable insulators without excessive loss by leakage," and he regards the Lauffen-Frankfort experiment as proving the correctness of that position. "The adoption of the three-phase current only increases the difficulties to be met" on account of increased complication in the transformers, switches, etc., and he maintains that "the only novelty which the Frankfort exhibition brings to light concerning it are important constructive improvements in its application" which he claims to be "almost without exception" his own; "for the first large multiphase generator and transformer, as well as the first practical motor without moving or rubbing contact" were his constructions. He credits the three-phase current "as applied at Frankfort" entirely to Mr. Nikola Tesla.

The New York Electric Club will, it is announced, shortly hold a most interesting and important meeting. Mr. Rosewater, the well-known proprietor and editor of the Omaha *Bee*, one of the leading newspapers of the West, went this year to Europe to study the various systems of government telegraph there. He made a very exhaustive investigation and was the more able to do so from the fact that he is himself an old telegrapher, who made an enviable record as a member of the United States Military Telegraph Corps during the War. He is now president of the Old Timers Telegraph Association. Mr. Rosewater has returned to this country and will now bring the results of his observations before the New York Electric Club in two or three weeks' time. Mr. Rosewater, it is understood, was specially recommended to the care of the various European Governments by our own State and Post Office departments, and the occasion, therefore, will be one of the first importance, especially as Mr. Rosewater, who is an eloquent advocate of placing the telegraphs under national control, believes that the facts and evidence in his possession fully justify the stand taken on this subject. While our opinions are adverse to the national control of telegraphs, we have no doubt of the interest of the proposed meeting, the date of which will be announced to members of the club when fixed upon.

The Brotherhood of Electrical Mechanics was founded in August, 1890, in the city of Chicago, and it now occupies quarters containing a lecture hall, reading-room and the beginning of an electrical library, situated in the Fullerton Block in that city. The organization has been established both for educational and benevolent purposes, and it has recently issued a prospectus setting forth its objects as above stated. The benevolent objects of the Association are the care of sick and disabled members, the burial of deceased members, and aid to unemployed members in securing positions. The prospectus takes pains to announce that it is not "a labor organization in the general acceptation of the term" and that it "unequivocally objects to strikes or anything that will interfere between employers and employés." So far as we are aware, this is the first association of its kind yet organized among electrical mechanics, and the effort made by the issue of this prospectus to extend the organization to other cities will doubtless be attended with success. When twenty-five separate stations have been established in other cities, it is announced that it is the intention of the Brotherhood to hold a national convention.

The Prospectus of the European Sims-Edison Torpedo Company is severely criticised in the *Electrical Engineer* (London), in its issue for October 9. That journal states that the company has been launched by financiers who know their business.

£150,000 out of the £201,000, which is the nominal capital of the company, will go to the vendors. "What," inquires the journal quoted, "does the company get for the £150,000?" It answers, "patents, designs, etc., of a torpedo *controlled* by electricity." The article thereupon asserts that "there are five hundred men in this country (England), any one of whom will for a sum of £500, design as efficient an electric control as that of the Sims-Edison—will design a piece of apparatus that shall carry an explosive as heavy as that in the Sims-Edison torpedo; that can be lowered or raised out of the water; that can be moved through the water, and its course directed as easily and as effectively as can the Sims-Edison torpedo." It grants that the Sims-Edison mechanism is "*pretty*," but thinks that £150,000 is altogether an "imaginative value" for it. The idea which has been adopted from the London *Times* in the prospectus of the company, that this mode of controlling a torpedo boat could be applied to life-boats, is met with the statement that "no boat ever built or ever designed could be manœuvred miles up and down the coast through the surf during a heavy storm by any electrical device at present known, the boat being controlled through wires connected with a stationary dynamo on shore." The writer of the article also thinks that those who have applied for shares have "gone it blind." "They may have drawn a winner, though the probability points rather to a blank."

One of the most Valuable Reports presented to the attention of the Convention of Street Railway Managers recently held at Pittsburgh, was that of Mr. J. S. Badger, of the Edison Company. This gentleman has been for a long time making thorough investigations with a view to a comparison of the economy of electric railway service, with that of horse and cable-railways. One of the curious facts ascertained by Mr. Badger is, that electric machinery under different conditions exhibits a wide variation in its performance. Whereas, in the case of one road, one in six of the armatures has to be repaired monthly, another makes an armature last nearly a year without repairs. On one road a constant leakage of from 20 to 30 amperes was shown to exist. A comparison of a very elaborate character, between electric cable, and horse-traction street railways is made in this report, which includes the experience of twenty-two electric roads, forty-five horse railroads and ten cable roads. The average cost per passenger carried on the electric roads is 4.53 cents, on the horse railroads 4.98 cents, and on the cable roads 4.77 cents. The best performance on any of the electric railways was one electric h. p. for every four pounds of nut coal, or five pounds of slack burned at the station; and this was obtained with a high speed single cylinder non-condensing engine, supplied with steam by plain return tubular boilers and fed with coal by mechanical stoking. Mr. Badger's report was a very long one, and of course can be only very briefly noticed here. It is, however, a very valuable contribution to street railway statistics.

The New System of Running Electro-Motors, devised by Mr. H. Ward Leonard, seems to promise immediately valuable results. Its applications are numerous. As the new system has rendered it feasible to operate motors at any speed without sacrifice of efficiency, it is almost impossible to perceive at once all the applications to which it may be put. Obviously one of the most important, will be that of railway propulsion wherein the motor may exert its full power in starting trains, and thereafter graduate its power to that exactly required. The slowing down when it is desired to stop a train, may be accomplished with equal ease and economy. Its application to elevators in buildings will also be one of the most desirable improvements yet brought out in connection with electric elevators, as the power can be graduated exactly to the load in the elevator car. Electro-motors, as heretofore run, cannot practically accomplish this. The control of the elevator may be effected in the elevator car itself, and the movement of the car is smooth, not only in stopping, but in starting and in accelerating speed. No jar is experienced upon instant reversion of the motor, and the car remains perfectly at rest when desired.

When the elevator is started the power derived from the central station line is the least, the current increasing gradually as the speed of the elevator increases.

A New Telegraph-Machine is announced as the invention of Herr Jaite, Director of Telegraphs in Berlin. Two electro-magnets, one worked by a positive, and the other by a negative current, set in motion a perforator which punches holes in a tape. These holes are not mere dots and dashes as in the Morse system, but are arranged in such manner, that on joining them with lines, letters of the Roman alphabet are formed. It is stated that the machine can be worked with extraordinary ease and that at a recent trial between the Berlin and Hamburg Stock Exchanges, which is a distance of nearly 200 miles, from 65 to 85 messages per hour, or 25 to 35 words per minute were sent. It is anticipated that the reading of perforated tapes and the ability to perforate tapes for messages will be easily acquired by the public, so that pre-perforated messages may be passed into telegraph offices for immediate transmission.

A Curious Statement has been made by the pilots of Havre with reference to two lighthouses at La Hève, one of which was fitted with electrical lighting apparatus, while the other continued to burn oil. They say that during foggy weather the brilliancy of the electric light is very much more reduced than that of the oil-lamps, so much so that sometimes, in very foggy weather, while the light from the oil-lamps was plainly visible, it was impossible to discern that of the electric light. The *Electrical Review* (London), states that a deputation of ship captains have also represented at Trinity House that the electric light in some of the lighthouses, more especially those near the entrance of the Thames, sometimes becomes invisible, while the lights from the light-ships and lighthouses burning oil can still be distinctly seen; even the gas lamps from towns on the neighboring coast being visible at the time. This effect has been supposed to be due to peculiar atmospheric conditions. A further complaint with regard to electric lights when used for lighthouse purposes confirms the complaint which was made against the electric light in the Hell Gate lighthouse in the East River near New York City, and which caused the substitution of oil-lamps for the light complained of. According to the journal quoted this complaint was to the effect that navigators are unable to see around them owing to the dazzling brilliancy of the electric light, and that the powerful bundles of rays cast such deceiving images upon the surface of the waves that sailors become quite confused and are often unable to apppreciate their situation on very dark nights. The *Electrical Review* admits that "these charges are of a most serious nature, whether true or unfounded; meanwhile the adaptation of electricity is extending to second and third class lighthouses. Something should be done at once to investigate the truth of these charges, and if there is anything in them, steps should be taken at once to so modify the reflectors and other accessories that these alleged disadvantages, if they exist, should be eliminated."

Electricity, in the Manufacture of Beer has been found very useful in sterilizing water and thus preventing the growth of disease ferments in the wort, during the process of fermentation. Professor Werner von Siemens of Berlin, the well-known electrician, has performed a series of elaborate experiments upon the sterilization of water through the action of ozone generated by electricity in air passed through tubes. The ozone thus gained is passed through the water to be sterilized. The action of electricity is, therefore, indirect, the ozone being the real sterilizing agent. The success of the experiments has been so marked that further experiments which will be made on a more extensive scale, are expected to fully demonstrate the economical value of the application to the business of brewing.

"Silver-Bronze" has a tensile strength of 57,000 pounds per square inch and 20 per cent. elongation. It can be rolled into thin plate, and has been drawn into small wire. It has an electric resistance considerably higher than that of German silver, and it is anticipated that it may afford better and cheaper wire for rheostats than any other known alloy.

MINING AND METALLURGY.

THE Manufacture of Continuous Sheets of Iron and Steel direct from fluid metal was discussed, as to its possibilities, in a very interesting paper read by Sir Henry Bessemer, F. R. S., before the Iron and Steel Institute of London, on the 7th October. He first reviewed some industrial operations which have some analogy to the process under consideration, as paper-making, etc. He stated that the subject had occupied his attention as far back as the year 1846, at which date he took out a patent "for the production of tin foil and sheet lead direct from the molten metal," the invention being included in a patent for the manufacture of glass, but never having been practically developed. He further stated that about two years ago he received "a parcel from America containing a small sample of sheet metal which was being successfully manufactured there." As he was informed, this sheet "was made by a slight alteration or improvement on" his "patent of 1857, for rolling continuous sheets and thin bars of iron direct from fluid metal." Sir Henry stated that the person forwarding this sample offered one-half of his patent if Mr. Bessemer would undertake its introduction into England, which offer was not accepted. The sample, however, is considered by Sir Henry as proving "beyond doubt or question the important fact that fluid metal may be chilled and formed into continuous sheets between rolls that are kept cold." He also compliments the American spirit of enterprise, which is "prompt to recognize, to adopt and to improve upon inventions brought forward in Europe." In 1846 Mr. Bessemer experimented in the manufacture of continuous sheets of glass, and on one occasion was able to produce a sheet 70 feet long by 30 inches wide in about 3 or 4 minutes, that part first rolled having become hard and brittle while the latter part of the sheet was still in its plastic state. Iron and steel, retaining their malleable condition for a considerable time after passing from the fluid to the solid state, give more time for treatment before they become cold than glass, which presents special difficulties owing to the rapidity with which it becomes brittle in cooling. A very interesting narrative of an experiment performed by him in 1856 is given by the author of this more than ordinarily interesting paper:

At the period mentioned I was carrying on a secret process of manufacturing bronze powder at my works at St. Pancras, where I was also making my iron and steel experiments; and in the bronze works I had in daily use a pair of 12in. chilled rolls. I saw at once that these rolls would enable me to make such a trial of the scheme as would prove the possibility or otherwise of producing a continuous sheet direct from fluid iron. Unfortunately these rolls were working at some distance from the model converting-house, and in a room that was carefully locked and guarded, and into which no strange workmen could be permitted to enter. I therefore had to depend entirely on myself for these experiments. I employed a common 20lb. crucible as a converter, and after melting 6lb. or 8lb. of pig iron in it, I immersed the orifice of a fire-clay blow pipe in the metal, which was by this means wholly decarbonized. No manganese or spiegel was added to it. I then seized the crucible in a pair of tongs and ran with it into the bronze works. This naturally occupied some little time to accomplish, and when I arrived at the rolls the metal in the crucible had assumed the solid form, and could not be poured out. After several unsuccessful attempts, I at last succeeded in reaching the rolls with some fluid metal. The crucible was lifted on to the back roll as shown, and the molten iron was poured in between them. The rolls were set at about $\frac{1}{30}$in. apart, and a thin sheet was obtained some 3ft. or 4ft. in length. The small stream from the crucible did not spread itself far along the wedge-shaped space between the rolls, and as the quantity poured fluctuated a little, so the breadth of the plate increased or decreased in the same ratio, giving an undulating line to the

edges of the plate, some portions of which were afterwards rolled to a thinner gauge. The sheet thus produced had a clear surface, almost wholly free from oxidation and absolutely free from scale. It was as tough as any rolled iron plate I had ever seen; indeed it left no doubt in my mind of the entire success of this system of rolling thin sheets direct from fluid metal.

A Unique Scheme for the Exhibition of the Mines of Leadville at the Columbian Exposition has been originated by Mr. A. A. Blow. This is no less than the painting, and exhibition of a cyclorama, in a special building adapted to the purpose of exhibiting in a realistic manner the city of Leadville and its neighboring mines, and, according to the Leadville *Herald-Democrat*, reproducing "graphically by means of scenic painting" the whole great Leadville mining district, "situated 10,000 feet above the sea, and encircled by the grandest mountain ranges and passes in the West." In connection with this an exhibition will be made of modern mining machinery and of the various minerals and mineral products peculiar to the Leadville region. The building for the exhibition of the cyclorama is proposed to be octagonal, having a diameter of 150 feet and a height of 60 feet, containing two stories, the upper of which will contain the cyclorama, the lower containing the other exhibits. To meet the expense of exhibition it is proposed to organize a stock company with a capital of $125,000. This is certainly one of the finest ideas which has been brought out in connection with the World's Fair. It is much to be hoped that it will be carried out in all its details.

Of Asbestos Mining in Canada it may be said, that till within a few years, Canada was not thought of as a source of supply, the principal part of fine asbestos fibre having been obtained from Italy and Corsica at a price varying from $250 to $300 per ton. The discovery of immense quantities of asbestos in the Province of Quebec has increased the resources for the supply of this valuable material; yet, notwithstanding, prices have advanced, and Quebec asbestos now brings a price almost equal to that of the best Italian. The uses of asbestos are constantly increasing. Only the commoner grades are made into steam-packing and fire-proof felt for building purposes. As often happens in the course of human affairs, it was a misfortune that led directly to fortune in the discovery of the asbestos deposits of Quebec. Only when the forests in Thetford and Colraine were destroyed by fire, was the abundance and value of the deposits perceived. A statement printed in the *Board of Trade Journal* (Quebec) shows that the annual profits from the Johnston-Irvine mine are not less than $100,000, yet, four or five years since, this mine might have been purchased for $5000. An attempt to reduce the price of asbestos on the part of European manufacturers who have accumulated a temporary excess of the material, has been met by the storing of the output of the mines on the part of the miners, and it will probably fail.

The Mining Interests of Colorado are, according to the *Mining Industry and Tradesman*, in a most gratifying condition. The management is passing into more experienced hands; managers and superintendents are becoming more familiar with underground workings and details of mining; and foremen, shift bosses and other employés are gaining in knowledge of their duties. Other radical changes have gradually been made in mine supervision, and managers are now generally practical miners; the journal referred to says that "the mines are no longer asylums for incompetents."

The Discovery of Diamonds in Meteoric Iron, in Arizona, in June of the present year, by Prof. A. E. Foote of Philadelphia, is the second recorded find of this sort. Its scientific interest lies in the fact that it adds another important proof of the distribution throughout the universe of the elements of matter as chemistry has revealed them to us. The diamonds varied in character from black to white, but were extremely small. The first discovery of this form of carbon was made in 1887 by Russian mineralogists. A very interesting paper describing these diamonds and the meteoric mass from which they were taken was read by Prof. Foote at the last meeting

of the American Association for the Advancement of Science, held in Washington. His account of the discovery was exceedingly graphic and interesting to mineralogists, and it has attracted much attention.

Investments in the Flat Top Coal Fields in Virginia have, according to the *Manufacturers' Record*, been so profitable that the statement of the profits is almost incredible. It asserts that over $300 have been returned to the investors for every dollar invested by them. The owners are the Flat Top Coal Land Association of Philadelphia, and upon the top of the large profits above named, they have recently effected a sale of timber to the Little Kanawha Lumber Company of Boston, Mass., of some 200,000 tulip-poplar, cucumber, ash and linden trees, 20 inches in diameter and upwards, from their lands on the headwaters of the Guyandot River in Raleigh and Wyoming counties, at the average price of $2.50 per tree, as the trees stand on the ground. The journal quoted states that the trees are all to be counted and branded and then conveyed to the purchaser by deed. It further states that the "sale will bring to the Association, for these soft wood timbers, about as much per acre as the lands cost it a few years ago, leaving the hard wood trees, the smaller soft wood trees, the fine coking coals and the land free." This sale of timber is said to amount to $500,000 or as much per acre as the property cost the Association.

Accidents in Mines are attributed, in a recent editorial in the *Colliery Engineer*, "more to direct disobedience of orders, or carelessness, than to any other causes." However, the article takes the position that immunity from accidents cannot be secured by legislative enactments. The enforcement of discipline by colliery officials is insisted upon. A degree of severity appears to be warranted in the discipline of mines which, perhaps, would be considered as unjustifiable in the conduct of any kind of business wherein there is less liability of danger to life and limb. The article therefore thinks that the discipline should be as exact as in a military command. The argument is based upon reports upon American and British mine inspection which indicate that the larger portion of mine accidents is due to "carelessness or disobedience of orders."

"A Gem-Bearing Granite Vein in Western Connecticut" is the title of an interesting contribution by L. P. Gratacap to a recent number of the *Scientific American Supplement*. The vein is situated in the county of Litchfield, having "a *strike* south of west and north of east, and a distinct dip northwest, by which it is brought below the gneiss rock which forms an overhanging wall on the northerly side of the granitic mass; while on the southerly edge, the same gneiss rock makes an almost vertical foot-wall, and exhibits a sharp surface of demarkation and contact." The greatest width is about 51 feet and the length of the vein 300 feet. Mr. Gratacap says that "upon the most cursory inspection of the vein the eye is arrested by the large masses of crystalline orthoclase, the heavy beds of a gray, brecciated quartz, and the zones and columns of large-leaved mica." Only recently, in the attempt to secure mica, were discovered the gems contained in the vein. The mica is of very good quality—*book-mica* yielding *stove-sheets* of from two to three by four or five inches. Its transparency is very perfect. The gems are found in the gray, brecciated quartz, and are described as being very beautiful, but varying "extremely in quality and color." Some of them are opaque, fractured and irregular in grain, but at their centres contain "cores of gem-making material." The gems are beryls, grading from goshenite through "faintly green with blue reflections, and yellowish green, to davidsonite," and from this grade through "honey-yellows which form the golden beryls of trade and are of value. These stones have a hardness of 8, and when cut display much brilliancy." Others have "true aquamarine tints, and others seem to be almost identical with the 'Diamond of the Rhine.'" The stones of amber and honey shades are spoken of as being extremely beautiful. Mr. Gratacap does not think it is probable that true emeralds will be found in this vein. Some very imperfect garnets are also found.

Tin Mining in the Malay Peninsula has received, according to a recent official report, an impulse from the McKinley Bill which, as it is stated, has increased the demand for pig tin in the United States. Formerly this tin went directly to Great Britain, where it was first manufactured into tin plate and then exported to the United States. It may be that pig tin is in greater measure now coming directly to the United States instead of by the way of Great Britain as stated, but as the export of tin from the Straits Settlements to all countries for the year 1889 amounted to about $18,600,000, and the bulk of this went to Great Britain, we do not believe that the increase of shipments of pig tin to this country show a material and permanent increase. Reasoning from general principles, it does not seem possible, that with a tariff on tin so loudly protested against by a large portion of the American people, and the consequent probable revision of the tariff, before many years elapse, to reduce the duty, American capital can be so foolhardy as to invest largely in the manufacture of tin plate, for which, if pig tin is coming to this country in increased measure, it can only be wanted.

A New Method of Treating Ferriferous Ores, containing gold, silver or other metals, has, according to an Australian paper, been devised for the purpose of setting free the iron, leaving the gold, silver and other metals to be extracted from the residue by any process found applicable. Such ores are first converted into a salt of iron by treating them with sulphuric acid aided by the presence of metallic iron, zinc or other metal, and by a series of chemical operations the same material may be used over and over. It is stated to be necessary to roast some ores in order to drive off the arsenic and sulphur; and the process is aided by roasting, in the case of some ores not containing arsenic and sulphur. In the latter case the roasting is done in the presence of charcoal to reduce the quantity of oxygen contained in the ores. The ore is preferably ground in the presence of water, and when it is in a mud-like state acid is introduced, preferably, sulphuric acid in a sufficient quantity to convert the iron in the ore and the metallic iron which is afterwards added, into a salt of iron. The acid may be added as a liquid in an open vat or as a vapor in a closed chamber. The mixture is boiled, but no effect or reaction takes place with most classes of ores until a metal is added consisting of shavings or turnings of iron, scrap-iron or zinc. A reaction having taken place the iron in the ore is reduced to the form of a salt; if sulphuric acid has been used, the iron becomes sulphate of iron, which is washed away. After this the residue of gold and silver may then be sought for by its treatment in any well-known manner for the recovery of these metals. The sulphuric acid may be frequently used by retorting the sulphate of iron, which releases the sulphuric acid, and which also results in valuable oxides left in the residuum.

A New Coal Cutting Machine has been brought out by the Yorkshire Company, Ld., of Sheffield, England. This machine cuts both ways, so that when it arrives at the end of a seam, instead of having to be carried back to the place of commencement, it makes a backward cut. The machine weighs 2400 pounds, its height from the rails being only 1 foot, 9 inches. Its width, exclusive of the cutter-wheel is 3 feet, 2½ inches, and its length exclusive of guides, is 8 feet, 9 inches. The railway on which it runs has a gauge of 2 feet. The machine is operated by compressed air, two cylinders, respectively 9 inches diameter by 9 inches stroke, being employed. In order to facilitate the moving of the machine in the pit, a number of the parts are made detachable; as, the large cutter-wheel, carrying bracket, hauling drum and gearing. The general idea of this machine, as shown by an illustration accompanied by a description in *Industries* (London), shows that the problem has been well thought out and embodied in a thoroughly good mechanical design. It is plain, that if the rapidity of actual cutting be the same with this machine as with others, a considerable economy of time and labor will be secured by this method of reverse cutting.

MECHANICS.

A PROCESS was described by Mr. John Richards in a recent paper read before the Technical Society of the Pacific Coast, which he styled "rolling abrasion";—that is to say, the abrasion consists in the "disintegration of hard material by means of globular particles rolling under pressure." The process is the invention of Messrs. B. C. & R. A. Tilghman, of Philadelphia, well-known to the mechanical and engineering public as the inventors of the sand-blast. Mr. Richards illustrated the action by the conception of a number of small ball-bearings rolling under such pressure that they crush the material underneath them at their constantly changing points of support. Until the pressure has been increased to this crushing point they roll with comparatively little friction. Beyond this point Mr. Richards asserts that "they constitute the most effective means known of abrading the surfaces on which the balls roll, especially if the balls are hard and inelastic." The inventors were for a long time obstructed in carrying out the principle, owing to the difficulty of procuring globular particles of sufficient hardness. After many experiments they found that cast iron, when melted and divided very finely, took the form of small spheres like shot; but they also found that if exposed to the oxygen of the air in this condition, it took fire, and burned up instantly. They had, therefore, to devise a means of excluding the air in order to obtain the cast iron globules in a perfect condition. Mr. Richards asserts that by the use of the chilled cast iron globules, brown stone, marble, or any of the softer kinds of stone may be sawn with ordinary stone-saws four times as fast as by the use of sand in the ordinary way;—and that granite, which hitherto could not be sawn at all at a reasonable cost, is now cut by the aid of the globules at a rate ten times as fast as with sand. Another great advantage is that the wear of the saw-blades is only one-fifth as much as with sand. So rapidly has this new process come into favor, that although the invention is only nine years old, more than 250 firms are using it for sawing stone.

A New Engineering Laboratory is to be established at the Purdue University, Lafayette, Ind. A communication to the *American Machinist* states that the main building is to be 50 by 110 feet, with monitor ceiling 40 feet from the floor, and is to be supplied with power from a boiler room 25 by 40 feet in dimensions. The power is to be derived from a hundred horse-power Babcock and Wilcox boiler, delivering steam to a Harris-Corliss triple expansion condensing engine having cylinders 8, 15 and 22-inch diameter by 24 inches stroke. Other parts of the equipment are an 85,000-pound Schenectady locomotive equipped with the Westinghouse system of automatic brakes; an experimental stand-pipe, in which may be maintained any desired head for hydraulic experiments with high-level and low-level tanks separated by weir-plates; two large Morris centrifugal pumps; a No. 5 Dean steam-pump; several injectors; a thirteen-inch Leffel water-wheel; a 100,000-pound Olsen testing machine; a 2000 pound Olsen cement-tester; a 10 horse-power transmitting dynamometer; a 50 horse-power Alden friction-brake, and a large amount of small miscellaneous apparatus. It is evident that this University intends to take first rank in the list of technical schools.

A Very Ingenious Bottle-Stopper has been brought out in London. The interior of the neck of the bottle, in the part where the neck is usually reinforced, that is, from the mouth to a little distance below it, is formed with an internal screw-thread blown in the glass when the bottle is manufactured. The glass part of the stopper is also made with a corresponding screw-thread, but smaller in diameter than the space it is intended to fill. Over this

stopper is screwed a bushing of cork. The stopper thus packed with cork may be screwed directly into the mouth of the bottle and taken out by unscrewing, the cork bushing adapting itself to the threads in the neck of the bottle through its elasticity and pliability, and making a perfectly tight joint. These stoppers are adapted for use in bottling beer, wines, spirits, and mineral waters—also for stopping fruit jars. The improvement, though very simple, is extremely mechanical in appearance, and it is likely to attain a wide popularity.

Apropos of the Effect of Centrifugal Force on the transmitting power of driving-ropes, as referred to in our notice of "Edison's Magnetic Belt" in our November number, a paper by Mr. B. H. Coffey, read before the Engineers' Club of Philadelphia, may be referred to. In this paper he asserts that the power of transmission in driving-ropes is very much reduced through the centrifugal force of the pulleys, this force opposing the wedging tendency of the ropes in the grooves and much lessening their frictional adhesion.

Progressive Examinations of Locomotive Engineers and Firemen, is the title of a new book intended to assist railway firemen and locomotive engineers to a better knowledge of the things they each must know to acquire a high degree of competency for their positions. At the same time it gives the fireman the means for qualifying himself for the higher position of engineer, by placing within his reach, bound in flexible covers, a book which he may carry with him in his pocket for perusal when otherwise his time would be wasted. Those who can answer satisfactorily and intelligently all the questions asked and answered in this handy catechism will be competent to pass any examination instituted to test their qualifications as Locomotive Engineers. As the title indicates, the examinations for different grades of qualification are distinct; as, "after *one* year's service," "*two* years' service," etc.; and these are interspersed with lectures so well prepared and carefully considered with reference to the guidance of students at their different stages of progress, that they cannot fail to be most vital helps to the attainment of more advanced knowledge and position. The author of the book is the editor of our able and esteemed contemporary, *The Locomotive Engineer*, Mr. John A. Hill, of New York, who is also the publisher.

Mechanical Drawing, as represented in technical articles, has been made the subject of criticism by *Invention* (London), which charges that "the average article on mechanical drawing is as useless a kind of literature as can be referred to." It claims that articles written under this head generally relate properly to geometry, and that this is necessary because there is nothing in the art to admit of long essays. It claims that the conventional methods of draughting are not learned by reading, but by seeing, by which we understand our contemporary to mean that the only way to learn mechanical drawing is to stay by the side of an expert and see him perform his work. This is certainly taking a very narrow view of the subject and is making an exception of the art of drawing as being, unlike other arts, incapable of being presented in text-books. We fear our contemporary has not seen the excellent series of articles which have been for some time appearing in the *Railroad and Engineering Journal*, published in New York City, and which are written by Mr. M. N. Forney, the able editor of that periodical. It appears, also, that if seeing can teach examples of good design, these, with explanation of the principles upon which they are made, published in books or articles, might become a very important factor in the training of mechanical draughtsmen. It is true that some books, and many articles published in technical papers do really leave out the practical part of machinery designing and devote space principally to the discussion of the solution of geometrical problems; but that this is necessarily the case is entirely disproved by the important series of articles now appearing in the *Railroad and Engineering Journal*, already referred to. The article under review also deprecates the accumulation of notes, sketches and memoranda, as indicating want of confidence in personal resources. This we regard as

also and altogether a mistake. The accumulation of notes, sketches and memoranda by mechanical draughtsmen is not because of their lack of confidence in their own powers, but simply as a means of economizing time; and it will be admitted that it is perfectly proper to follow precedents established by admitted authorities and by able designers, thus saving the time necessary for many computations and greatly facilitating the progress of work. It has been in our experience to employ many draughtsmen, the ablest of all of them being one who made much use of notes and sketches.

A Curious Scientific Toy was recently exhibited at a meeting of the Royal Society in London. It is a heat engine, based upon the principle that nickel, magnetic at ordinary temperatures, promptly becomes non-magnetic at a temperature of 572° F. The construction of the engine, if it may be called such, is as follows: A disk of copper is suspended by two strings so that it can swing like a pendulum, and has attached thereto a piece of nickel by means of a magnet mounted upon the copper disk. An alcohol lamp placed below the disk heats the nickel until it becomes demagnetized and drops away, when the copper pendulum makes an oscillation. During this oscillation the nickel cools sufficiently to regain its magnetic character and is caught up by the swinging magnet only to be passed again over the lamp which causes it again to drop, and so on, the pendulum being thus kept in motion.

Small Inventions made by Great Men have frequently marked the progress of mechanical construction. One of the latest is a faucet invented by no less a person than Sir William Thomson, President of the Royal Society of Great Britain. The general design of this faucet is that the valve face shall be rubbed upon its seat at every opening and closing, in such manner that both the valve and the seat constantly tend to wear each other, thus maintaining a perfect fit. One of these faucets has been arranged to be opened and closed by machinery while water is permitted to flow through it, and has been opened and closed 540,000 times and is still perfectly tight. A manufacturing company of Liverpool has undertaken to place this invention before the public. An American patent has been obtained for it, which is said to be controlled by the company referred to.

The Surface-Coloration of Metals exposed to high temperatures has been studied by Loewenhertz, who performed a series of experiments with a view to the coloration of metals for decorative purposes. By variations in the duration of the exposure to heat, as well as variations in temperature, he finds that the coloration of copper surfaces may be made to range from pale orange to dark gray, and of brass from yellow orange to green. For some reason the exact conditions of temperatures and time of exposure necessary to obtain specific results, have not been made public.

A New Machine for Making Embroidery has been brought out in Switzerland, and, according to report, is likely to revolutionize the most important manufacturing interests of the Swiss Republic. The magnitude of this industry is indicated by the statistics for 1890, which show that the value of cotton embroidery exported from the Republic in that year was no less than $16,000,000. The new machine is said to more than triple the present production of hand machines, and, at the same time, to produce a better quality of goods. The manufacture of embroidery by hand machines is a very old industry in Switzerland, dating back to 1827; and, at present, not more than 5 per cent. of the embroideries are made exclusively by hand. It is said that there are about 23,000 of these hand machines now in use in Eastern Switzerland, the number of needles in each machine being 250, and the number of stitches made by each needle per day being 2000.

The Use of Movable Sidewalks is, according to *Electricity* (Chicago), likely to be inaugurated at the coming World's Fair. This was proposed some years ago as a means for rapid, or, at least, for more rapid, transit than can be accomplished by ordinary walking in the city of New York, the plan being to have a sort of endless

chain of platforms constantly running at a speed no greater than would accord with safety in stepping on or off, and running in opposite directions on both sides of the street. A company which is styled "The Columbian Movable Sidewalk Company," has submitted its plans to a committee upon whose decision will depend their adoption. In order to demonstrate the practicability of the scheme an experimental track has been erected and tested in the presence of a number of interested persons and representatives of the press. The track is 900 feet long, and is in the form of an ellipse. "The movable sidewalk consists of a continuous rail of overlapping platforms. Each platform is twelve feet long and rests on a separate car-truck. The trucks are coupled together by a short link." Seats may be placed upon the platform if desired. The velocity of the endless chain of platforms is from 2 to 3 miles per hour. Of course one walking in the same direction as in which these platforms are moving will add to his progress by the distance he walks.

A New Tube Joint designed for use in steam, gas and water pipes, and which is capable of being made perfectly tight under very high pressure, has been recently patented in England by Mr. Joseph Aird. The flanges of the tubes to be joined are provided each with a small groove on its meeting face. In the groove is placed a ring packing of asbestos, and the flanges are then drawn together by two collars (slipped over the pipes against the outside of the flanges) and the use of powerful through-bolts and nuts. The collars are so formed that one projects over the meeting line of the flanges; thus forming an abutment which prevents the blowing out of the packing. It is stated that the joint withstands any pressure up to 5 tons per square inch; and it would appear that it would be peculiarly applicable to ammonia pipes in the erection of ice manufacturing plants.

A New Method of Lining Iron Kettles has been brought out by an English inventor, the lining being merely an interior shell of tinned steel, which may be either spun or cast, and which is intended to take the place of the now common tinning or enameling. It is said that this lining is cheaper than enameling, as it obviates the costly process of burning and annealing. It is also stated that it is intended to apply the process to lining articles with tinned brass or copper instead of tinned steel, whereby it is intended to produce a copper or brass pan at the same price as an ordinary tinned iron one. The latter articles must, however, have the important defect that they do not conduct heat any more rapidly than the tinned iron vessels, and therefore can never compete with copper as culinary vessels, the superior conductivity of copper so distributing the heat throughout the vessel that the scorching of the contents at points which receive more intense heat than others is thus prevented.

Double Metal Wires are now made in France by casting copper around a steel bar and then rolling and drawing the ingot down into wire. It is said that this wire is strong and cheap, and that it stands the atmosphere well. Speaking of this invention, *Electricity* (London) says, "the idea is very old, but it is only latterly that it has been applied with success. Compound wires, tried at Cardiff by the Post Office some years ago, failed, the reason being that the atmosphere passed through the copper and oxidized the iron cores.

The late Mr. Edward Faron, a marine engineer well-known in engineering circles as the chief of construction at Roach's ship-yard in Chester, Pa., whose death left a vacancy which must have been difficult to fill, is to be succeeded by Mr. Dickinson, a brother of the eminent patent lawyer of that name. He has long been connected with this establishment and by his own efforts has raised himself to one of the most responsible positions in it.

The Cheapness of Artificial Refrigeration is indicated by the fact, that even in the coldest countries, where natural ice is always plentiful, the artificial ice-machines are being introduced. The Minneapolis Brewing Association is stated to be putting a large refrigerating apparatus into its new brewery, notwithstanding that ice in that city has always been cheap.

POPULAR MISCELLANY.

APROPOS of the Coming Great World's Fair, *Machinery* (London) states that fairs are as old as civilization. The ancient Greeks and Romans held fairs and, as early as the fifth century, fairs were held in French and Italian cities. They were introduced into England in A. D. 886. India and other Asiatic countries have held fairs from time immemorial. The ancient Mexicans and Peruvians, at the time of the discovery of America, held fairs, and they were "specially fostered and patronized by the Government of old Mexico. The arrangements were well studied and systematic. Transactions were conducted under the inspection of magistrates appointed for the purpose, and perfect order was maintained. The difference between modern fairs and those of the ancients, consists mostly in the substitution for traffic (the original feature of the ancient fairs), that of competitive exhibition.

The Manufacture of Tinplate in this country is, from time to time, held out as already past the period of experiment by various journals which appear to publish their statements chiefly in the interest of the tariff imposed by the McKinley bill. A recent issue of the *Manufacturers' Review* states that the board of directors of the Savernake Steel and Tinplate Company has been held in Richmond, and important business looking to the "early establishment of the works" was transacted. It says that the "enterprise has been most favorably received by business men in all parts of the country, and is attracting general attention; and it promises to announce, in a future issue, "particulars of the consolidation of three prominent Virginia mineral and manufacturing companies with the Savernake Steel and Tinplate Company, which will render this company the most powerful yet established within the United States, being provided with the absolute ownership of all the raw materials entering into the production of steel and tinplate, together with a very large capital." Without positively denying the correctness of these statements, we must be permitted to think that they are delusive. In our department of Mining and Metallurgy, we notice in this number the asserted increase of exportation of pig tin from the Malay Peninsula, and express the opinion that the investment of American capital in view of the present uncertainty that the tariff upon tinplate will be continued would be foolhardy in the extreme. The *Manufacturers' Review* states that there is a strong disposition to invest in the above named enterprise reported from London; and that the probability is that the works will be built on a scale much larger than at first proposed. It also states that the development and working of tin ores of the Blue Ridge tin field are of the "most flattering sort," and it professes to regard "the early establishment of tin mining and smelting and tinplate manufacture in Virginia" as *assured*. We should be glad if we could take the same rose-colored view of the situation as that of our contemporary, but we have as yet seen neither facts nor statements which appear to us sufficiently reliable to warrant such an opinion.

The Minnesota Appropriation, $50,000, made by the Legislature of that State for exposition purposes, is admitted by the manufacturers and business men of that State to be so insufficient that a movement is on foot to increase it. To this end an address has been made to the several counties in the State, which by the original enactment were required to furnish each their proportion of the fund, urging them to increase their several proportions in order to increase the fund to $100,000.

The Multiplied Uses of Compressed Air force themselves upon the attention of mechanical readers, and are interesting in general points of view as a feature of modern progress. This development is taking place more largely in France than in any other country. Refrigeration by means of

compressed air is now applied in Paris to morgues for the preservation of dead bodies, which may be kept for any length of time by this method. As a means of preservation for food for cities in a state of siege, refrigeration by expansion of compressed air presents some advantages over that effected by the use of ammonia, not being so liable to disturbances in operation. Motor engines run by compressed air from a central power station, the air being conveyed in pipes, are now a rapidly developing system, the air being heated before being inducted to the engines to such a degree that in expanding it does not cool below the freezing point. Among medical applications of compressed air are air baths; motors for generating medical electricity; and for propelling dental apparatus. Other applications are the propulsion of elevators, grinders, pumps, wringing machines, sewing machines, embroidery machines, machines for hashing meats; saws, printing-presses, lathes, etc. The use of compressed air as a means for conveying time indications is also one of the new applications, the pulsation of compressed air columns being the means of transmitting the movements of a pendulum at a distance.

Aerial Photographs, which partake of the nature of bird's-eye views, are now obtained by means of kites, by Mr. A. Batut, and other persons who have followed suggestions made by him, among whom is Mr. E. Wenz, of Rheims. *La Nature* has described these experiments at length, with illustrations, from which we gather that the kite used has the form of a quadrilateral, composed of two isosceles triangles, the extremities of the frame being connected by a cord, and the whole covered with paper re-inforced with cloth at the angles of the frame. The camera is attached to the kite in such manner as to form a part of it, by means of a triangular support screwed to the frame just above the centre of the main rib, and in such manner that the field of the objective is entirely free. The shutter is automatically operated by mechanism adjusted before the kite is raised. The line of the kite is wound upon a wooden bobbin operated by a winch. Wenz modifies the method of Batut by using a wood and card-board camera with two objectives, one a simple and the other a large angular one, and he lightens the weight of the apparatus by using aluminum for the mountings of the objectives. He operates the shutter after the method of Mr. Batut. He also has added to the reel a multiplying gear by by which it may be wound in rapidly. By means of this new apparatus negatives from 18 to 24 centimetres are claimed to have been taken with entire success, some of them being taken at heights of 305 metres, the height at which the picture is taken being easily determined by calculation from the actual size of some of the objects photographed and their size as represented on the negative. The applicability of this method to military operations at once suggests itself.

The Hours of Labor in some Departments of English railway service, according to the report of a Committee of the English House of Commons, are much longer than those of railway employés in the United States. According to the blue-books issued by the Committee, the average hours of passenger guards and brakemen are 13.37 hours per day; those of passenger engine crews are 10.14 hours per day; those of freight guards and brakemen, 9.81 hours; those of freight engine crews, 6.08 hours; those of signal men, 11.41 hours. The *Engineering News*, in commenting upon these figures, points out the peculiarity that "contrary to the general rule in the U. S., the engine crews, both freight and passenger, work longer hours than train crews, and the freight crews, as is natural, work longer hours than the passenger crews; though there is not so much difference between them as one would expect, or as exists in this country." It adds that "in this country an engine crew is considered to have done a day's work when it has run from 100 to 120 miles, and consequently the normal passenger day's-work is from 4 to 6 or 7 hours only, including time lost at terminals, while the freight crew's day's-work may lengthen out to 10, 12 or 15 hours." The article in which these comparisons

are made was published in the issue of the *Engineering News* for October 17th, in a space of three and a half columns, and is extremely interesting, bringing out many other facts of interest which would repay the perusal of those who are interested in labor statistics.

A Piano Played by Electricity, that is to say, one in which electricity was made the means of vibrating the strings, was exhibited at the Frankfort Exhibition, where it attracted, it is said, as much or more attention than any other exhibit. Immediately over each string or strings corresponding to a particular note, an electro-magnet is fastened, these magnets being controlled by a damper in such manner that pressure upon a key causes an electric circuit to be made, an automatic interrupter rapidly breaking the current so that a series of magnetic impulses causes the strings to vibrate for the production of the tone. The ordinary piano action is also used, and the vibration of the strings by percussion of the hammers only is possible, but the combination of the two effects, that is to say, the percussive tone and the continuous vibration produced by the magnets as described, is said to be exceedingly fine; or either of the two effects may be produced independently by use of the damper. If the instrument be played percussively, and subsequently a connection be made to cause the magnets to act, the effect of the magnetic vibration of the strings is that of a distant organ. Small storage batteries provide the necessary electric current.

The Mineral Resources of New Caledonia have been discussed at length in the *Moniteur Officiel du Commerce*. In the north of the island gold, copper, antimony and lead are found, and towards the west there are deposits not only of coal, but of various descriptions of limestone, slate and gypsum. Nickel-ore was discovered in 1867, and since that time the workings of the nickel, cobalt and chrome mines have been considerably developed. Exceptional samples of nickel-ore contain 26 parts nickel, 13 parts magnesia, 3 parts iron, 45 parts silica and 13 parts water; but the average ores contain only from 7 to 12 per cent. of nickel. The supplies of nickel along the coast are said to be almost inexhaustible. On the 1st of January, 1890, there were 115 nickel mines open, representing a region of 27,785 acres. Chrome ore is found in large quantities in the serpentine formation of the island, occurring either in veins or in stratified beds in clay basins. Cobalt ore is also found in considerable quantities in the same formation. These ores average from 3 to 5 per cent. of oxide of cobalt. The district of Diahot has been found to contain large quantities of gold, copper and argentiferous lead. Numerous discoveries of gold have also been made in the north of the island, and it is believed that the island actually contains a wealth of gold greater than that of Australia. This district also contains copper in an exceedingly thick vein. At the bottom of a mountain in the district a block of copper weighing five tons was discovered, and it was exhibited at the Paris Exposition of 1889. On the left bank of the Diahot River, which gives its name to the district, argentiferous lead is also found, and indications point to the existence of rich veins, but the most abundant ore in New Caledonia is iron. It is found accompanying nickel, chrome and cobalt. The iron is not found in veins or beds, but exists in vast masses. An abundance of coal is also found on the west coast. Trials of coal mined in the neighborhood of Noumea on board of various steamships, are said to have demonstrated that it is equal to the best Australian coal, with the additional advantage of creating less smoke in burning. Eight beds of coal are stated to have been found having a thickness of from 24 to 36 feet. Manganese, iron pyrites, marble and lithographic stone exist in the island, and traces of mercury, tin and platinum have also been discovered. There are also large deposits of kaolin and gypsum.

A Machine for Drilling Square Holes, which, about a year ago, attracted some attention in the mechanical world, is now to be put on the market by an English company. It drills either geometrical or irregular shaped holes. The essential features of the invention are comprised in the drilling head, which has a spindle, fitted at

about the middle of its length with a ball-joint carried in an adjustable bearing, so that the spindle may not only be revolved upon its vertical axis, but at the same time may be vibrated as required by the shape to be drilled. The mechanism by which the drill's vibration in accordance with a prescribed pattern is accomplished, cannot easily be described without drawings. The cutting tool is a square piece of steel sharpened away to a single cutting edge having its point on the centre line. It is said that the drill cuts a neat, well-defined hole; and that the speed of drilling is about equal to that on a good ordinary drilling machine,—the latter part of the statement being, in our opinion, somewhat doubtful. Moreover the machine is capable of drilling a tapered hole; the hole becoming either smaller or larger as the drill penetrates according to special adjustments of the machine.

As to delays in the New York City Post Office, frequent complaints have reached us of late, and in order to ascertain the reason of these delays we communicated with the Superintendent of the Railway Mail service, Mr. R. C. Jackson, who writes us that "it is a fact beyond question that this office is in receipt of second and third-class matter in excess of its ability to handle with the same promptness accorded to first-class matter. The present force and facilities are taxed to the utmost, and the department at Washington, D. C., has been urged to add to both, to enable the office to dispose of the increased business thrown upon it." When the New York Post Office was first erected, it was supposed that the facilities it would afford would be ample for the accommodation of the mails, but notwithstanding that numerous branch offices have been established in different parts of the city, it is now apparent that the space occupied and the force employed are entirely insufficient. We state this that our subscribers may wait a reasonable time before deciding that any omission in addressing the magazine to them has been made in our publishing department.

The Manufacture of Bricks from Waste Sand employed in grinding and polishing plate glass has been successfully accomplished. Considerable quantities of this waste accumulate at the manufactories, these plates being ground by means of wooden plates faced with iron and supplied with sand and water. The waste contains about 15 per cent. of the glass abrasions and about 2 per cent. of iron particles which are ground away. It attracts moisture, and in the manufacture of bricks it has to be dried and is subsequently moulded under an enormous hydraulic pressure. It is then subjected in a furnace to a temperature of 2732° F., at which temperature chemical combination of the glass with the sand takes place, producing a perfectly white brick, having a specific gravity of 1.5, entirely resistant to the action of acids and frost, and having a fair degree of strength. It is possible also to enamel bricks with beautiful colors for use in decorating fronts and interiors.

Pure Platinum and Its Alloys are stated to be prepared now by a new process, the assertion being made upon a high scientific German authority, W. C. Heraus. The details of the process, however, have not been given. The impurity in platinum produced by this process is not more than 1%. A striking characteristic of platinum at this degree of purity is its softness; but, if alloyed with iridium, the result is a product of very great durability. The most suitable proportions are said to be from 1 to 2 parts of iridium in 100 parts of the alloy. The originator of the process is Herr W. C. Heraus, who used, in making the alloys, iridium having a specific gravity of 22.35. At this specific gravity the iridium is as hard as blue-tempered steel and is only fusible in very small quantities by the strongest heat of the oxy-hydrogen flame. Mr. Heraus has also alloyed pure platinum with rhodium.

A Boom in Mining Property before many months elapse may be confidently predicted. In fact, it may be said to have already begun. The Chicago *Tribune* in discussing "Mining as an Industry" claims that it is the safest and most profitable business on earth. It states that there are less failures in legitimate mining than in any other commercial business. It quotes many of the American mines as paying

from 25% to 40% dividends per annum on their capital stock, and as many of these stocks were purchased at from 25 to 50 cents on the dollar, the percentage of profit on the actual investment will range from 60% to 100% per annum. A change in the management of mines renders investments safer than formerly, and good mining stocks are more difficult to secure. An important feature of mining is that it is a cash business. From other sources it is learned that inquiry for valuable mining properties is largely increasing, and as the accumulation of large fortunes in stock speculation which were formerly possible are no longer in sight, and as the real estate boom has passed its culmination, capital is likely to look for more inviting channels, than which none can be more inviting than investments in good mining property.

Of Emery Wheels an elaborate report has been made by Dr. Coleman Sellers of Philadelphia, Pa., Prof. J. E. Denton, and A. R. Wolff. The qualities constituting a good, solid emery wheel, as established by these gentlemen are "safety under the widest conditions of use and misuse; rapidity of cut; freedom of cut at moderate pressure; reasonable amounts of wheel-loss and power-consumption; evenness of wear; general staying quality; and reliability under the widest range of circumstances." Of fifteen varieties of emery wheels tested, six were found "too unsafe to warrant their general use, 57% of the wheels bursting under the same conditions which other wheels passed through uninjured. Eleven varieties (among which were included the six unsafe varieties) were found to be such slow cutters that the average metal-removal of ten of them was less than the general average of all the wheels" and "only four were found to be rapid cutters out of the fifteen varieties tested." One of the latter "wore so rapidly that the cost of its rapid cut was unreasonable." "Of the three remaining, one was found to work at a greater cost than the tanite wheel, and thus the question of superiority was narrowed to two wheels which in the judgment of the testing board require further trials to determine their relative value." Of these two, the report states that in every series of trials "the productive capacity of the wheels increased, the average of the last cuts of all the series being greater than the average of all the first cuts," while of the thirteen other varieties tested "the average of the last cuts was less than the average of the first."

A Very Ingenious Improvement in Level-Tubes has been brought out by a manufacturing company in New York City, the improvement being the backing of the tube by a phosphorescent compound covered by a water-proof lacquer. This enables the position of the bubble to be seen as well in the dark as in the light, and the instrument will be a great convenience to mechanics who have to work in dark places. Pipe fitters are often obliged to use a level in places where the position of the bubble is extremely difficult to see, and wherein it is difficult to place a lighted candle in such a relation with the tube as to show the bubble distinctly. This difficulty is entirely removed by the improvement named.

An Interesting Instrument has been devised in France as an aid to the reading of small print. It consists of a concave lens reflecting an enlarged image of the print upon a small plane mirror which lies upon the sheet of paper just above the line desired to be read, and which may be slid over the paper in the progress of the reading as desired. The paper or book, laid upon a table, thus forms a stand and firm support for the instrument, and it is very convenient in use. The instrument would be very useful, we think, in the reading of dimension-figures upon drawings which have been greatly reduced in scale by any of the numerous processes now employed for reproducing such drawings in technical publications.

The Lake Marine Exhibit at the World's Columbian Exposition is to be placed in charge of Mrs. Annie C. Meyers, widow of the late Capt. Victor E. Meyers, well-known to American lake navigators. Mrs. Meyers was formerly in the Patent Office, and has been prominently connected with many public societies and institutions. She is, therefore, thought to be fully qualified for the position named.

MACHINE-SHOP NOTES.

EVERY ONE says that we Americans are masters of the art of casting; and in many respects we are. There are several reasons for this. In the first place we have better cast-iron and can do with success things that mechanics of other nations would not dare attempt. In the second place we manufacture more than we build; and we generally want several pieces from one design; and casting lends itself to that better than forging and machine work do. In the third place most parts may be made more cheaply by casting than by forging and machine work; and if we have the metal that will make them, and the brains with which to make them right, there is no reason why we should not cast them. These things react. Because we have better cast-iron we have been able to make better castings; this has led us to make more castings; and the increased experience has brought it about that we are able to make better cast-iron and better castings from it, than if we had not such good cast-iron. Just how far this improvement will go and this superiority continue, I have no idea; I know that we are casting screws of sizes and of finish that would make Old-World mechanics stare. A good pattern well rammed with the aid of intelligence as well as of biceps, and poured with skill as well as with an iron sufficiently liquid by nature and heated by art, to make it pour well, and the trick is done—if we have properly blackleaded the moulds.

* * *

My ideas have undergone a change on the subject of making rivet-holes. I used to think that punched holes in iron plates were weaker than those which were drilled. I now find that they are really a trifle stronger—if they have been properly punched. The reason is that there is a certain flow of metal around the punch. When it starts in through the plate it makes a certain depression in it before any metal appears on the other side; then when the plug falls out it will be found of less density than the plate from which it was punched. Some of the metal has been forced from before the punch into the walls of the hole, making a sort of bushing of compressed iron which renders that hole less liable to tear when shearing strain is placed upon it, than if it had never been so reinforced. For steel plates I still stick to the notion of the desirability of either drilling the rivet-holes or reaming them out after punching; the reason being that the operation of punching effects a sort of tempering of the walls of the hole; and the metal thus tempered is more brittle than it was before having this change effected in it.

* * *

Very few boiler-makers seem to take advantage of one very important thing in riveting together plates—the fact that the holes punched in the plates are tapering. There is always a die having a greater diameter than the punch; and this causes the hole to be slightly tapering. The thinner the plate the greater the taper, for a given punch and die. Now, in putting the plates together, if the two wide ends of the holes are put together, or if the narrow end of one hole is put next to the wide end of the other, there will be less strength in the joint, when it is filled with the rivet, than if the two narrow ends are put together so as to make an hour-glass shape. You can see for yourself that if the shank of a rivet is made to fill such an hour-glass shaped hole, it will be like a "lewis" or a dove-tail, resisting by its double taper as well as by its heads, the tendency to separate the plates.

* * *

You would not think that such a little thing as the way in which the end of a caulking tool was ground would affect the tightness and the strength of a riveted boiler seam? Yet it is so. If you take

the ordinary caulking tool which has a sharp edge, you will find that its action when it is made to condense the metal along the edge of one plate is to make a scar along the base of that edge, in the surface of the other plate; and this scar weakens the plate, just as a nick in a bar of iron or steel weakens it and tends to make it break there rather than in any other place. If you will chip off the rivet heads and open out a joint made by such a sharp-edged tool, you will find that the tightness effected by the tool is very slight; the metal of the upper plate is to some extent jammed down against the surface of the lower one, but there is no great area of absolute contact between the two; only a narrow line. Now use a tool having its end rounded with a considerable radius, and use it so that it will make the edge of the upper plate concave instead of plain. Then open out the joint as before, and you will see that there is no scar in the lower plate, thus making it stronger than if there was such a scar; also that there has been effected an absolute contact between the two plates, extending over quite a width. The thinner the plate of course the wider this strip. Thus for two reasons the round-nosed tool does the better work.

* * *

Did you ever stop to think upon how slight a thing the running of your establishment depended—a matter of a little belt-lacing? If a miserable little strip of calfskin should slip or give way, your entire plant would have to wait until you could fix it or put in another one. You have a great heavy main belt, fully half an inch thick and a yard wide; you have enough strain on it to spring the floor to which the jack-shaft is hung; and all that strain, which makes that great main belt creak, is taken by a miserable little strip of tanned leather which a cautious man might hesitate to use if he wanted to commit suicide and wished to be sure that he had something that would bear his entire weight of 160 pounds. Of course the best lace to use, in most cases, is none at all. There are places where it is absolutely impossible to use an endless belt; but they are few, and yours is not one of them. Now, however, that you have a laced belt, it might be to your interest to see every now and then that none of the strands were cut through or likely to be broken. They cross each other, and where they cross the belt between the belt and the pulley there is danger of their cutting each other. The belt is laced the wrong way. All the strands on the side next the pulley should be parallel with each other and with the belt length. The work should be done from the centre of width of the belt towards the edges. The holes in the belt ends should be oblong (oval is the usual term) with the greatest length running with the belt length. Where the lace runs through the holes care should be taken that it is rolled neatly upon itself so as to present a circular cross-section. The knot should be on the outside of the belt and the ends should be long and tucked in through several strands on the outside; in order to diminish the danger of having the joint slip or let go. You can't be too particular in this matter.

* * *

We are trying carbon cores over in our foundry; made just like electric arc lamp carbons, only not quite so hard, and more porous; besides which there is a slight perforation running through them. They stand more banging around, they will last forever and a day without losing their strength or shape, and the work from them finishes up better than that from sand cores.

* * *

You are running that planer with a seven-inch belt, but Setscrew over the way has one just like it, that he is running on about the same work, with a six. Yet you sneer at Setscrew when you have nothing else to do. Well, before you point out the old-fashioned oil-cup that you see in his eye, you had better take out from your own that thirty-foot strip of double leather belting two inches wide. Your floor is down on one corner, and from present appearances since you put in that big punching and shearing machine, it is going to stay down; your planer is none too stiff in the backbone, and is sprung. It is a light planer and I think that it will always be

sprung one way or another. If it is all right with a light load on it, it will be sprung with a heavy one, and if you stiffen it up against a heavy load it will be askew when there is nothing particular on it. The best thing that you can do is to get a paper box of good black lead, punch a few holes in its top, and dust a lot of it in the ways. You need not trim off the extra two inches of belt, but you will find that they will not be needed. Your coal pile will be the better for it, and so will that planer, because you can't rub cast-iron on cast-iron without wearing cast-iron away.

* * *

They say that the devil goeth about like a roaring lion, seeking whom he may devour. Well, why shouldn't he? Why shouldn't the lion? The Lord gave him an appetite, and provided that lambs, missionaries, and such like would appease it. Now you have a certain appetite for knowledge. It is your right to have it. The more of it you have, the healthier you will be, and the better off you should get. You should gratify it. Go about seeking what points you may get that will help you in your business. Cross over to Harker's and find out how he drills those long, deep holes. Go around to Pollock's and see if there isn't some reason why he can make those malleable castings without a loss of more than one in twenty while you lose one in five. See where Eyre gets his coal. Ask who sold Brandt that machine oil. Learn from Stokely whether that new brand of Pittsburgh steel is all that it is cracked up to be. Inquire of Reasoner if he has learned anything new about melting steel in that cupola. Everywhere you go, find out something. Leave something in exchange if you can, for pride's sake and to make it more certain that you will get something next time you go; but always find out something.

Trading facts is the only kind of swapper that leaves every swapper better off after a year's time, than if he had not swapped.

* * *

You are having trouble with the packing of that accumulator plunger. Most people have trouble with that sort of thing. That is because they don't know how to pack such things. You are using the old-fashioned U cup-leather. There is a better way, that I learned at Edgemoor. Take a wide leather gasket and soak it. Make a wooden ring of semicircular section, having its internal diameter just the same as the diameter of the plunger. Shape the gasket over it so that you will have a cup-leather ring, or a leather cup-ring, or whatever you call it. Shape it over further until the inside and the outside edges of the ring are bent over the flat side of the ring. Then when the leather has about got its form, take out the ring, and fill the U with blacklead and tallow, and next sew to the flat side of the ring a plain gasket having its inside diameter the same as the plunger diameter. Now use this U-section collar as a packing ring. When the water pressure gets great, of course it will be squeezed tight. Some of the blacklead and tallow will come out and will lubricate the leather and plunger; so that the wear will be lessened. The greater the pressure the greater the lubrication. A pressure sufficient to close an ordinary ring around the plunger so tight as to scrape off all the lubricant that you could apply, will only bring out more blacklead and tallow between the ring and the surface rubbing it. Thus your packing collars will last about five times as long.

* * *

Judkins set off every line of that drawing, from the original to his paper, because he had no tracing-paper handy. And all the while there was within five feet of him a bottle of colorless benzine. If he had only known enough he could have stretched his opaque paper over the drawing that he wanted to copy, and could have made it temporarily transparent with the benzine; and he could have drawn on it while it was transparent, and after he was through there would have been no sign that there had ever been a bottle of benzine within fifty miles of him. Judkins has no gumption, anyhow. He never finds out things. He reminds me of what some one said the other day about a would-be farmer. "*He* a farmer? Why, he couldn't even plant his foot and raise dust!"

COMMENT & CRITICISM.

THE paper on "Sewage Disposal in England," published in the September ENGINEERING MAGAZINE, is a good example of vigorous engineering style and happily illustrates the literary capabilities of engineers. Its author, Mr. T. Kennard Thomson, I understand, is a gentleman who has thus far devoted his professional work entirely to railways and bridges, and his recent incursion to the field of successful sanitary authorship may be considered a stroke of success not often attained. His paper, however, betrays a lack of familiarity with some phases of the subject which effectually proclaims the novice. For instance, he states that intermittent filtration has been proved over and over again to be a failure by reason of "being too expensive in requiring too great an area of land for effectiveness." This statement will certainly surprise many members of the engineering profession, whatever its effect on the public at large. It probably will surprise especially the authorities of the many English towns where intermittent filtration is in successful operation. Moreover we have some remarkably successful examples in this country at Lenox, Medford, South Framingham and Sherborne Reformatory in Massachusetts; Cranston, R. I.; Norristown, Pa., and Morris Plains and East Orange, N. J. Mr. Thomson could also find an interesting and successful example of intermittent filtration as designed and constructed by Col. George E. Waring for the Asylum for the Insane at London, Ontario, described in the seventh annual report of the Provincial Board of Health of that province. Clearly Mr. Thomson, at the time of writing his article, had not heard of the experiments on intermittent filtration as conducted for the last three and one-half years by the Massachusetts State Board of Health at their experimental station at Lawrence.

Mr. Thomson's next statement is that sewage farms, while still advocated by some, are being generally condemned. This I imagine will also surprise many. The long-since exploded idea that the product of properly managed sewage farms is inferior to that of crops raised by ordinary methods is repeated as though it were an original discovery. Before absolutely condemning sewage farms, Mr. Thomson may very well make another trip abroad in search of more light, and the sewage farm at Berlin is suggested as one which he may profitably study. There he will find a sewage farm of 20,000 acres, serving satisfactorily a population of 1,600,000 persons. This area is nearly equal to an ordinary American township. On such an area a considerable number of laborers are employed, and these with their families are distributed in cottages over the farm. Drinking water is taken from wells sunk wherever needed in the fields. The death-rate among the farm laborers is said to be lower than among a similar class of laborers outside the sewage-irrigated area.

Mr Thomson, like all novices, is nothing if not radical, and we accordingly find that having in two short paragraphs dismissed the work of the most eminent filtrationists and irrigationists as failing to furnish satisfactory purification, he then essays to thrust his lance through the most of the chemical methods; and away he goes full tilt against lime, salts of barium, aluminum, manganese and the rest, and we are for the moment left in doubt as to just how sewage is to be purified at all if everything thus far tried is so entirely a failure. Luckily Mr. Thomson comes to the rescue with porous carbon as the universal solvent of the sewage purification problem, though he is frank enough to tell us that of the two places cited where porous carbon has been used (Coventry and Southampton) the process is a success only at Southampton. Coventry he tells us we are not liable to copy much from.

At Southampton, where such moderate semi-purification of the sewage is needed as will permit its discharge into tidal water

without offense, fairly satisfactory results have indeed been attained, largely without doubt by reason of the intelligent treatment of the subject by the Borough Engineer, Mr. W. B. G. Benwell, who has brought to bear upon the special problem at Southampton careful judgment and mature experience. There are, however many grades of sewage purification. In this country we have a number of cases where by reason of streams receiving sewage, which are also the sources of public water supplies at points below the sewage outfalls, the method of purification adopted must be such as to insure the potability of the effluent. This implies not only the removal of noxious organic matter, but of disease germs, and thus far there is no evidence that any large proportion of such germs either are, or can be removed by the use of porous carbon.

One might infer from Mr. Thomson's paper that a new discovery of vast importance had been made. As a matter of fact porous carbon may be said to have been used for many years, the first patent essentially embodying its use having been taken out in England in 1852. The material used at Southampton and Coventry is manufactured by the Porous Carbon Company of London, and is, I believe, protected by letters patent. In the new sewage works at Richmond, England, the chemicals used are lime and a special preparation of sulphate of alumnia, sulphate of iron and carbon, as also prepared by the Porous Carbon Company, but it is noted that inasmuch as an effluent of a high degree of purity is at times required at Richmond, provision is made for further purifying the effluent from the Porous Carbon Company's chemical treatment when necessary by filtration through a filter bed composed of layers of gravel, sand and carbon. These facts show that what does for one place will not of necessity do for another, and that there are porous carbon processes and processes, some of which Mr. Thomson clearly didn't see when he was in England. The fact that porous carbon is a commercial article manufactured expressly for use in sewage purification should of itself have made Mr. Thomson somewhat chary of recommending it as the *sine qua non* of sewage purification. At the present time the foreign owners of patented sewage purification processes are looking to the United States as their next great field of operations, and an American engineer abroad in search of precedents may well go slow as to most of the so-called chemical processes until he is sure that the information imparted is of a disinterested character.

SANITARY ENGINEER.

New York, November 5, 1891.

Trees Destroyed by Electricity.

I NOTICE in the Electrical Department of THE ENGINEERING MAGAZINE for August an account of the destruction of an elm-tree by lightning, which I can more than parallel. In the summer of 1884, the house of Mr. Olcott, the cashier of the Connecticut River Bank in this village, standing on a slight rise, a hundred yards back from the main street, was struck in a heavy "thunder-shower," and one chimney partially knocked down, and a lot of shingles and weather-boarding knocked off. The fire was promptly extinguished, and the house soon repaired, but a large elm which overhung it, and which was in no wise shattered by the bolt, immediately began to wilt and soon died entirely.

The next summer three or four more large elms, from eighteen to twenty-four inches in diameter and about sixty feet high, and fifty feet apart, forming an avenue from the street to the house, all withered and died, without apparent cause, and we have always supposed that they were affected by the electricity of the storm of the previous summer, as none of the other trees on the street, and there are many, and some much larger, have ever shown any signs of disease or decay. The branches of all these trees interlaced, and I have supposed that the discharge which struck the house and killed the first tree, was communicated to the others, with sufficient intensity to finally destroy them, though its effects were not immediately visible. Trees on the hills surrounding the village are struck almost every summer, and usually

much shattered, pines and chestnuts especially, but the lightning seldom strikes in the valley. Very truly,

SAMUEL WEBBER.

Charlestown, N. H., October 10, 1891.

Testing the Strength of Buildings.

IN Mr. Edward Atkinson's very interesting article in the November number of THE ENGINEERING MAGAZINE on the "Lessons of the Park Place Disaster," the following passage occurs:

"An architect employed by the New York *Herald* to report upon the fall of the building is quoted, in that paper, as saying that in many cases it would be impossible to determine whether floors are overloaded or not."

Mr. Atkinson further very kindly states that he feels "certain" that the architect "has been misrepresented in this statement." Having written the report above referred to, I would respectfully call Mr. Atkinson's attention to the same, published in the *Herald* on August 27th last, in which I supplement the remark quoted with this proviso: "*Without careful experiment with the material with which the floor is loaded;*" a statement with which it is evident the distinguished author fully agrees by his submitting the tables given in his paper, which he particularly states are "based upon careful tests," and "give the safe load and limit of deflection of every shape and size of timber that is ordinarily used, *together with the weights of most kinds of merchandise placed on any floor.*" Very truly yours,

CHARLES H. ISRAELS, Architect.

New York, November 13, 1891.

The Day as a Unit of Time.

IN Dr. Sandford Fleming's paper on "Our Old-Fogy Methods of Reckoning Time," in THE ENGINEERING MAGAZINE, Volume I, page 211, this paragraph occurs:

"To effect any measurement there are two essentials: First, a starting-point or zero. Second, a scale or unit of measurement. The Washington Conference of 1884 has determined both of these. The zero is the instant of mean solar passage on the anti prime meridian, which is 180° from the meridian of Greenwich. The unit is the smallest and most available measure of time which nature presents to us, the period occupied by a single rotation of the earth on its axis, and is denoted by two successive solar passages on the zero meridian."

The period of the earth's rotation is a sidereal interval. The unit adopted by the Conference is a mean solar day. There are 365 mean solar days to 366 sidereal days. A mean solar day is the average lapsed time between two successive culminations of the sun over the same meridian. A sidereal day is the unvarying lapsed time between two successive culminations of a fixed star which alone is the measure of the earth's rotation on its axis. The unit adopted can therefore hardly be termed a natural one. Though based upon the diurnal and annual movements of the earth, it is artificially adjusted so as to correspond as far as possible with the irregular apparent movement of the sun and yet be regular. G.

London, October, 1891.

The Care of Roads.

THE general treatment of the subject of roads is not entirely satisfactory. A matter of vital importance either is not mentioned at all or is dismissed with a very few words. This is the preservation of roads from destruction—prevention of wear—and the consequent saving of the expense of repairs. If an ounce of prevention is ordinarily worth a pound of cure, in this case it is worth at least two pounds. It costs just as much to destroy a road surface as it does to repair it. Of course some parts of the destruction is necessary, hence some repairs or rather renewal will remain necessary. It is evident that if we destroy nothing we do no work, for work in hauling loads is work of destroying something—combined destruction of road surface and vehicles.

Whatever road surface we may have (it should always be the most economical, however much or little cost it may require) we should so regulate traffic over it as to cause the most economical wear; that is, the wear which costs the least in combined producing and repairing. That part of the wear necessarily due directly to horses' feet can be reduced only by reduc-

ing the work required and is dependent upon the regulation of wheels and the condition of road surfaces. Since the rims of wheels and the surfaces of roads alone act and react upon each other, we may consider all other parts as auxiliary to these two—as securing the proper action.

My general definition of cheapest road would be that surface which for a given cost, necessary foundation included, is best suited for its proper purpose and at the same time receives the nearest approach to proper use. This element of proper use I consider as extremely important. By proper use I mean with wheel rims or tires of most economical proportions, and consequent least destructive power. Such use would modify (by lessening) first cost, maintenance cost, rise of cross section and at the same time greatly lessen the cost of using.

Let us consider the effect of insufficient tire width. Suppose that having a given load sufficiently well supported upon a given tire to prevent unnecessary cutting of a pavement, we wish to haul double the amount without increasing this depth of cut as economy requires. If we depend upon increasing the diameter of the wheel we must make it about four times as great, to get the required double supporting area, without increase of cutting or crushing effect. It is much easier and better to simply double the tire width. The effect of doubling the load without changing the size of wheel or width of tire is to cause at least four times the cutting effect. This is true for road materials which are hard and homogeneous throughout the depth to which it is cut or crushed. For soft homogeneous material the effect of a given tire under a double load varies from four times the original cut to seven times as much. This is taking no account of water effect upon soft materials. It is this water which makes it impossible to keep such soft roads good under narrow tires and in spite of which tires of proper width will keep them in good condition.

But considering street pavements, it is fair to say that vehicles having only half of the proper economical tire width produce at least four times that combined destruction to pavements and themselves which would be produced under proper regulations. It is safe to say, too, that generally springless vehicles, constituting a large part of the freighting vehicles in this country, have less than one-half of this proper economical width of tires.

J. M. HEISKELL.

Memphis, Tenn., November 10, 1891.

EDITOR'S EXCHANGE TABLE.

AN INDEX TO CURRENT TECHNICAL LITERATURE.

THE tabulated list contains the names of exchanges most frequently quoted. To save space the abbreviations respectively prefixed are employed in the list of articles following the index. Illustrated articles are indicated by an asterisk (*), continued articles by a dagger (†), and concluded articles by a double dagger (‡). Orders for copies of publications mentioned should be sent direct to the addresses given.

A A.....American Architect. *m.* 15c. Boston.
A E .....Architectural Era. *m.* 25c. New York.
A & B....Architecture and Building. *w.* 15c. New York.
A J R A..American Journal of Railway Appliances. *m.* 25c. New York.
A M. ....American Machinist. *w.* 6c. New York.
B J C....Boston Journal of Commerce. *w.* 6c. Boston.
C A B ....Canadian Architect and Builder. *m.* 20c. Montreal.
C E . ....Colliery Engineer. *m.* $2 per year. Scranton, Pa.
E E L ....Electrical Engineer. *w.* 3d. London.
E E N Y..Electrical Engineer. *w.* 10c. New York.
E L.....Electricity. *w.* 1d. London, Eng.
El.. .....Electrician. *w.* 4d. London, Eng.
E C .....Electricity. *w.* 7c. New York-Chicago.
E R L.....Electrical Review. *w.* 4d. London, Eng.
E R N Y...Electrical Review. *w.* 10c. New York.
E W.....ElectricalWorld. *w.* $3 per year. NewYork.
E.....Engineering. *w.* 6d. London, Eng.
E M J.....Engineering and Mining Journal. *w.* 10c. New York.
E N.....Engineering News. *w.* 15c. New York.
I E.....Indian Engineering. *w.* As. 8. Calcutta.
I L. .....Industries. *w.* 6d. London, Eng.
I A.. .....Iron Age. *w.* 10c. New York.
I J M S...International Journal of Microscopy and Natural Science. *m.* 6d. London-New York.
Inv .....Invention. *w.* 6d. London, Eng.
J A E S...Journal of the Association of Engineering Societies. *m.* 30c. Chicago.
J O I.....Journal of Industry. *m.* 20c. San Francisco, Cal.
J F I .....Journal of the Franklin Institute. *m.* 50c. Philadelphia.
J N E W..Journal of the New England Waterworks Association. Quarterly. 75c. New London, Conn.
J S A.....Journal of the Society of Arts. *w.* 6d. London, Eng.
L E.....Locomotive Engineer. *m.* $1 per year. New York.
P A .....Progressive Age. *w.* $3 per year. New York.
P S.....Power-Steam. *m.* $1 per year. New York-Chicago.
P T.. ....Photographic Times. *w.* 15c. New York.
N .....Nature. *w.* 6d. London.
N B .. ...National Builder. *m.* 30c. New York-Chicago-St. Louis.
S A S.....Scientific American Supplement. *w.* 10c. New York.
Sc.....Science. *w.* 10c. New York.
S... .....Stone. *m.* 15c. Indianapolis, Ind.
R A E J..Railroad and Engineering Journal. *m.* 25c. New York.
R G.....Railroad Gazette. *w.* $4.20 per year. New York.
R M M...Railway Master Mechanic. *m.* $1. Chicago.
R R.....Railway Review. *w.* 10c. New York.
W E.. ...Western Electrician. *w.* 10c. Chicago.

ARCHITECTURE.

Chimney for the Narragansett Electric Lighting Co.* Providence, R. I. John T. Henthorn, C. E. (S A S–Oct 31.)

Experiments on Masonry Arches.* Trans. *Le Genie Civil* (S A S–Oct 31)

The Decorative Treatment of Natural Foliage.* † Hugh Stannus (J S A–Oct 9.)

Portland Cement in Australia. H. C. Mais, C. E. (E–Oct 2.)

Decorative Treatment of Natural Foliage in Architecture and other Arts.‡ Hugh Stannus (J S A–Oct 16.)

Architecture and the United States Government (A A–Oct 31.)

The Temple of Theseus.* W. Watkiss Lloyd (A A–Oct 10.)

English and French Cathedrals.* Barr Ferree (A A–Oct 10.)

Theatrical Architecture * † (A A–Oct 10.)

Comparative Architecture. Prof. Barr Ferree (A & B–Nov 7.)

Architectural Education. John Eisenmann (A & B–Nov 7.)

Fireproof Construction. John James Webster (I A–Nov 5.)

History of Prison Architecture. John R. Thomas (A A–Nov 7.)

Italian Architecture * (A A–Nov 14.)

Report on Tests of Fire-Resisting Materials. C. J. H. Woodbury, C. M. Goddard, and D. L. Lord (A A–Nov 14.)

The Advancement of Architecture.* Prof. Aitchison (A & B–Nov 14.)

Experiments with Flooring (Kansas City Architect and Builder *m.* 15c Oct.)

CHEMISTRY.

Further Researches upon the Element Fluorine* (N–Oct 29.)

Physical Chemistry—A Review (N–Oct 15.)

The Assay of Tanning Materials.† Dr. S. Rideal, F. I. C., F. C. S. (I L–Nov 6.)

CIVIL ENGINEERING.

Portland Cement in Australia (E–Oct 2.)

Trip Through the Auriferous Regions in Western Borneo.* Julian Deby (I L–Oct 6.)

The Nadrai Aqueduct, India* (E–Oct 23.)

A New Slope Stake Setter and Slope Indicator* (R A E J–Nov.)

The Strength of Columns and Struts. W. W. Robertson (I E–Oct 3.)

Junctions and Connections for Lines of Railway, With Numerical Examples. Thomas Alexander, M. A., C. E. (I E–Sept 26.)

The Effects of Salt in Mixing Cement Mortar. M. I. Powers (E N–Nov 21.)

Microscopic Tests of Cement.* Alden H. Brown (E N–Nov 21.)

ELECTRICAL ENGINEERING.

The Birth of the Dynamo.* Charles C. Randolph (E C–Oct 28.)

The Dependent Overhead or Underground System of Electric Traction. George W. Mansfield (E C–Oct 28.)

The Motor of the Frankfort-Lauffen Transmission and Three-Phase Motors in General.* Carl Herring (E W–Oct 30.)

A Perfect Electric Motor. H. A. Everett (E R N Y–Oct 31.)

Progress in Modern Incandescent Lighting.*‡ Dr. L. K. Bohm (E R L–Oct 16.)

The Ideal Electric Motor (E C–Oct 7.)

The Inventor of the Rotary Field System—Its Present Application and Future. Ludwig Gutman (E W–Oct 17.)

The Roberts Chromo Arc Light Pencil. Isaiah L. Roberts (E R N Y–Oct 14.)

Electric Railroading in the Current Year (E W–Oct 24.)

Electrical Practice in Europe as Seen by an American.*† Carl Hering (E W–Oct 24.)

Electric Railways of Pittsburgh and Allegheny City* (E R N Y–Oct 24.)

Electrical Power Transmission from Lauffen to Heilbronn, Germany (E R N Y–Oct 24.)

Motor Wiring. Thos. P. Grier (W E–Oct 17.)

Transmission of Power by Rotary Currents* (E R N Y–Oct 15.)

An Improved Phonograph Recorder.* Eustice Oxley (E C–Nov 4.)

The Economic Limit of Large Power Units (E E N Y–Nov 4.)

Brown's Three Phase Alternate Current Motor* (W E–Nov 7.)

Optical Science in its Relation to Electric Lighting* (E W–Nov 14.)

Counting A Nation by Electricity—The Hollerith System.* T. C. Martin (E E N Y–Nov 11.)

Oil Insulation for High-Tension Currents. Franklin Leonard Pope (E E N Y–Oct 28.)

The Telephone Problem in London (I L–Oct 16.)

Shiplighting by Electricity (E E L–Oct 23.)

Standard for the Resistance of Copper. Silas W. Holman (E E N Y–Nov 18.)

Pictorial Telegraphy—The Electro-Artograph E C–Nov 18.)

A Plan of Connections for Effecting Several Tests with one Galvanometer* (E L–Nov 13.)

The Cologne and Düsseldorf Municipal Central Lighting Stations (E L–Nov 13.)

ELECTRICITY—THEORETICAL.

Effect of Magnetism on Rods of Iron, Nickel and other Metals Which have received a Permanent Torsional Set* (E R L–Oct 16.)

Celestial Electricity (E C–Oct 7.)

The "Joule" "746" and the Watt. G. T. Evans (E E–Oct 14.)

Magnetic Circuits and Their Measurement. H. E. J. G. Du Bois (E R L–Oct 9.)

Polyphase Alternate Currents† (E R L–Oct 9.)

Determination of Currents in Absolute Electro-Magnetic Measure.*† G. F. C. Searle (E R L–Oct 9.)

Method of Measuring the Heat Developed on Account of Magnetic Hysteresis in the Core of a Transformer. J. A. Ewing (El–Oct 9.)

Magnetic Resistance. A. E. Kennelly (E W–Nov 7.)

Recent Progress in the Science of Magnetism. B. S. Giles* (E E L–Oct 9.)

Verification of the Law of Deviation of the Equipotential Surfaces, and the Measurement of Dialectric Current.* A. Perot (E R L–Oct 30.)

Recent Electrical Researches by Russian Physicists (E R L–Oct 30.)

Variation of the Electro-Motive Force of Batteries with Pressure. Henri Gibault (El–Oct 30.)

Polyphase Alternate Currents*† (E R L–Oct 23.)

Value of the Electro-Static Tension in the Dialectric (E R L–Nov 6.)

Measurement of the Loss by Hysteresis. Thomas Spencer (E E N Y–Nov 11.)

Magnetic Reluctance (W E–Nov 21.)

GEOLOGY.

Progress and Methods of Geologic Correlation by Means of Fossil Plants. Lester F. Ward (Sc–Nov 20.)

The International Geological Congress. D S. Martin (Sc–Nov 20.)

HYDRAULIC ENGINEERING.

Manchester Water-Works * (E–Oct 16.)

Storage Water-Reservoirs in Egypt (E–Oct 16.)

Therler's Electrical Water Level Recorded * (E R L–Oct 9.)

Manchester Water-Works * (E–Oct 30.)

Water Supply for Madras, India. Jno. F. Fisher (Indian Engineering *w.* As. 8. Calcutta–Sept. 12.)

On the Revolving Purifier for the Treatment of Water by Metallic Iron (I L–Oct 16.)

The Determination of the Available Energy of Water Powers. Francis R. Hart (E E N Y–Nov 18.)

Irrigation in India: Its Value and Necessity (E N–Nov 21.)

The Discharge of Water from Tanks * (I E–Oct 17.)

MARINE ENGINEERING.

The Barrow Depositing Dock* (E–Oct 16.)

Steel in Marine Engine Work (Inv–Oct 3.)

Superiority of Independent Condensers for Marine Engines on the Lakes. J. F. Holloway (A M–Nov 6.)

The Steamship Howard Cassard* (Seaboard, New York, 5c–Oct 15.)

Quadruple-Expansion Marine Engines (I L–Oct 23.)

Triple Expansion Engines of the S. S. *Inchbarre* (I L–Oct 23.)

The British Second-Class Cruiser *Beatrice** (E–Oct 23.)

Indian Cargo Barges* (I L–Oct 30.)

Shipbuilding Supremacy of Great Britain (E–Oct 30.)

Torpedo Boat Boom (E–Oct 30.)

Ferryboat Cincinnati* (A M–Nov 12.)

Improved System of Coaling Steamships (Engineers' Gazette *m.* 3d London–Oct.)

On the Use of Zinc in Marine Boilers (Ibid.)

The Mercantile Shipbuilding of the World (I L–Nov 6.)

Cellulose for Water-line Protection (I A–Nov 19.)

The Japanese Coast Guard Ship *Itsukushima** (E–Nov 13.)

MECHANICAL ENGINEERING.

The Forging-Press. W. D. Allen (IA–Oct29.)

A Shop Gas-Plant* (A M–Oct 22.)

Practical Brass Foundry.† Alex. Cairns (A M–Oct 22.)

New Works of the Berlin Iron Bridge Co (A M–Nov 5.)

Compound Air Compressors and Motors* (I L–Oct 9.)

METALLURGY.

Tests and Requirements of Structural Wrought Iron and Steel.‡ Alfred E. Hunt (I A–Oct 29.)

Elimination of Sulphur from Pig-Iron. J. Massenez Hoerde (E–Oct 16.)

Manufacture of Continuous Sheets of Malleable Iron and Steel direct from Fluid Metal. Metal. Henry Bessemer (I L–Oct 9.)

An Undescribed phenomenon in the Fusion of Mild Steel. F. J. R. Carulla.

Elimination of Sulphur from Pig-Iron.* Herr J. Massenez (I L–Oct 30.)

The Evolution of American Rolling Mills. Robert W. Hunt (E M J–Nov 21.)

The Properties of Alloys. Prof. W. C. Roberts-Austen, C. B., F. R. S. (E –Nov 13.)

Lead Galvanizing (E L–Nov 13.)

MILITARY ENGINEERING.

The Swiss Magazine Rifle (E–Oct 2.)

The Measurement of the Velocity of Projectiles. Capt. H. Capel L. Holden, Royal Artillery (E–Oct 23.)

The Graydon Dynamite Gun* (R A E J–Nov.)

Disappearing Turrets Nordenfelt Quick Firing Guns (E–Oct 30.)

Armor Trials at Annapolis (Army and Navy Journal *w.* 15c New York–Nov 7.)

The Failure of English Heavy Guns (I L–Nov 6.)

Armor-Plate Trials (E–Nov 13.)

MINING.

Our Sources of Tin. Geo. P. Merrill (S–Nov.)

Economic Geology of Silver.* H. A. Wheeler, E. M. (C E–Oct.)

An Apparatus for the Laying of Coal-Dust in Mines. R. B. Mawson (Ibid.)

Principles and Practice of Coal Mining on the Pillar System.*† W. S. Gresley, M. E. (Ibid.)

Coal Mining in the Belleville Seam No. 6 at St. Clair Co.* Ill. Leo Glück (Ibid.)

Steam Plant and Engines at Collieries (C E–Nov.)

The Prospector. Dan. De Quille (E M J–Nov 7.)

Tandem Tanks for Hoisting Water from Flooded Slopes. J. H. Bowden (EMJ–Nov 7.)

Sinking Through Wet Gravel and Quicksand near Norway, Mich.* William Kelly, E. M. (E M J–Nov 14.)

The Use of Telephones in Mines (Inv–Nov 7.)

PHOTOMETRY.

Practical Photometric Research. Ralph Conrad Richards (E R L–Oct 9.)

The Intensity of Light. A. B. Slater, Jr. (P A–Nov 16.)

PHOTOGRAPHY.

Photographic Definition.*† A. Mallock (N–Oct 8.)

Developing Instantaneously Exposed Plates (P T–Nov 6.)

Toning and Intensifying by Uranium Salts.

PHYSICS.

The Total Reflectometer and the Refractometer for Chemists (N–Oct 8.)

On the Electro Magnetic Theory of the Rotation of the Plane of Polarized Light. Prof. A. Gray, M. A. (I L–Oct 23.)

The Determination of the Specific Gravity of Liquids* (I L–Oct 23.)

On Van der Wall's Treatment of La Place's Pressure in the Virial Equation, in Answer to Lord Rayleigh. P. G. Tait (N–Oct 29.)

On Van Der Waal's Tratment of Laplace's Pressure in the Virial Equation. A Letter from Lord Rayleigh to Prof. Tait (N–Oct 22.)

Molecular Motion in the Development of Water Waves. Daniel S. Troy (Sc–Oct 30.)

PNEUMATIC ENGINEERING.

Distribution of Energy by Gas. Denny Lane (El–Oct 9.)

Leakage from Gas Mains and Pipes. Charles H. Nettleton (P A–Nov 2.)

An Improved Gas-Holder* (P A–Nov 16.)

The Wildemann Pneumatic Despatch System* (E–Nov 13.)

RAILROADING.

The Rolling Stock of British and American Railways (E–Oct 2.)

Rail Gauge Adjuster and Setter with Self-Indicating Graduated Gauge Index.*

Siam, Burmah and China Railway Connections (E–Oct 23.)

African Transcontinental Railroad* (R A E J–Nov.)

The Texas and Pacific Standard Coal-Car (R A E J–Nov.)

The Sumatra State Railroad* (R A E J–Nov.)

The Puerto Cabello R. R. Henry J. Cooke (E–Oct 30.)

The Bogie Man of Tubular Frame Cars (I E–Oct 3.)

Indian Railways (E–Nov 6.)

Effect of Temperature on the Strength of Railway Axles.† Thomas Andrews, C. E. (E N–Nov 14.)

Disadvantages of Mixed Unlocking Gear or Vertical Plane Couplers (R G–Nov 13.)

Recent Experience in Making Hard Rails. P. H. Dudley (R G–Nov 6.)

Locomotive Traction. A. Ewbank 2d (Indian Engineering *w.* As. 8. Calcutta–Sept 12.)

The Canadian Railways (E–Oct 16.)

Ventilation of Tunnel Railroads (R G–Oct 30.)

The Rolling Stock of British and American Railways (E–Oct 9.)

New South Wales Railway (E–Oct 9.)

Treatment of Waters used in Locomotives to Prevent Incrustation (R R–Nov 14.)

EuropeanStreet Railway Systems(EN–Nov21.)

SANITARY ENGINEERING.

The Richmond Main Drainage Works (Inv–Oct 3.)

Treatment of Sewage (Inv–Oct 3.)

Experiments in the Purification of Water for Drinking and Manufacturing. J. C. Dittrich* (E R N Y–Oct 17.)

The Possible Sterilization of City Water Supplies by Means of Electricity (E R L–Oct 23.)

Suggestions as to the Selection of Sources of Water Supply.* Frederic P. Stearns (E N–Nov 7.)

Calcutta Sanitation (I E–Sept 26.)

The Sanitation of Bombay (I E–Oct 17.)

STEAM ENGINEERING.

Proportions in Steam Engines. F. W. Clough (A M–Oct 22.)

A New Quadruple Expansion Engine* (R A E J–Nov.)

Radial Valve-Gears Graphically Treated. Robert H. Smith (I L–Oct 30.)

The Fly Wheel. Thomas Hawley (B J C–Nov 14.)

Cylinders for Compound Locomotives (R R–Nov 19.)

Efficiency of Non-Condensing Compound Engines (A M–Nov 19.)

On Some Details in the Construction of Modern Lancashire Boilers. Samuel Boswell (E L–Nov 13.)

MISCELLANEOUS.

Profit of Good Country Roads. Isaac B. Potter (The Forum *m.* 50c New York–Nov.)

American Shipbuilding and Commercial Supremacy. C. H. Cramp (Ibid.)

Commercial Future of the Pacific States. William L. Merry (Ibid.)

The Congress of Industrial Insurance (E–Oct 9.)

Net Profits of Manufacturing Industries (E–Oct 9.)

Cultivation of the Inventive Capacity. Leicester Allen (A M–Nov 5.)

Weather Record of the Fourteenth Century (N–Oct 8.)

Existing Schools of Science and Art. Oliver S. Dawson (N–Oct 8.)

The Koh-I-Nur. A Criticism. N. Story Maskelyne (N–Oct 8.)

Superior, Wis., as a Seaport (Seaboard *w.* 5c New York–Nov 5.)

The Electrophonic Piano.* Frank P. Perkins (E C–Nov 4.)

The Economic Basis of Imperial Federation (I L–Oct 30.)

Town Fogs and Their Effects. W. J. Russell (Nature *w.* 6d London–Nov 5.)

Navigating the Air* (Discovery *w.* 3d London–Nov 1.)

The First Telegraph Message. Stephen Vail (S A S–Nov 14.)

Governmental Science and the Civil Government (Sc–Oct 23.)

The Free Coinage Discussion (E M J–Oct 31.)

The Sun's Motion in Space (N–Oct 15.)

The World's Congress of Electricians in 1893. Col. R. C. Clowry, Chairman of the World's Fair Committee on Electricity (W E–Oct 31.)

The Ammonia Steam Engine (B J C–Oct 24.)

Rain Making in Texas. George E. Curtis (N–Oct 22.)

Color-Blindness Generally Considered (N–Oct 22.)

Street Cleaning. Louis H. Gibson (Paving *m.* 10c Indianapolis–Nov.)

The Recent Movement in Wages and Working Hours (E–Nov 13.)

SOME RECENT BOOKS.

A Conference on Manual Training. Boston: New England Conference of Educational Workers. [Pamphlet. 50 cents.]

A Course of Instruction in Ordnance and Gunnery. By Capt. Henry Metcalf. New York: John Wiley & Sons.

A first course in Machine Drawing (Tracing. Part 2. Electrical Engineering.) Arranged for use in technical and science and art institutes, schools and colleges. By Geo. Halliday. With preface by Prof. S. P. Thompson. New York: E. & F. N. Spon. [Folio. 21 plates. Paper. 75c.]

A Hand-Book of Industrial Organic Chemistry. By Prof. S. P. Sadther. Philadelphia: J. B. Lippincott Co. [8 vo. Cloth. $5.]

A History of the Modern Styles of Architecture. By James Fergusson. Revised by Robert Kerr, Professor of Architecture in King's College, London. Illustrated. New York: Dodd, Mead & Co. [8vo. 2 vols. Half-roan. $10.]

A Manual of Engineering Specifications and Contracts, Designed as a Text Book and Work of Reference for All Who May Be Engaged in the Theory or Practice of Engineering. By Lewis M. Haupt, A.M., C. E. Seventh Edition. Philadelphia: Henry Carey Baird & Co. [8vo. 328 p. Cloth.]

Design. By Arthur Lyman Tuckerman. New York: William T. Comstock. [12mo. 57 p. Boards. 75 cents.]

Eastern and Indian Architecture. By James Fergusson. New edition, with several hundred plates. New York: Dodd, Mead & Co. [8vo. 2 vols. Half-roan. $10.]

Economic and Industrial Delusions. A. B. and H. Farquhar, New York: G. P. Putnam's Sons. [Cloth. $1.50.]

Electric Transmission Handbook. By F. B. Badt, late First Lieutenant Royal Prussian Artillery. Chicago: Electrician Publishing Co. [12 mo. 97 p. Cloth. $1.]

Electricity and Magnetism. Translated from the French of Amédée Guillemin. Revised and Edited by Silvanus P. Thompson, D. Sc., F. R. S. New York: Macmillan & Co. [8oo. Cloth. 600 illustrations. $8.]

Electricity for Engineers; A Clear and Comprehensive Treatise on the Principles, Construction and Operation of Dynamos, Motors, Lamps, Indicators, and Measuring Instruments; also a Full Explanation of the Electrical Terms Used in the Work. Revised Edition. Part 1. Constant Current. By Charles Desmond. Bridgeport, Conn.: Frederick Keppy. [Price, $2.50]

Engine Runners' Catechism. Telling how to Erect, Adjust and Run the principal Steam Engines in use in the United States. By Robert Grimshaw. New York: John Wiley & Sons. [18mo. Cloth. $2.]

Essays: Scientific, Political and Speculative. By Herbert Spencer. [Library edition, containing seven essays not before republished.] New York: D. Appleton & Co. [8 vo. 3 vols. 478-466-516 p.]

Geodesy. By J. Howard Gore, Professor of Mathematics in Columbian University. Boston and New York: Houghton, Mifflin & Co. [12 mo. 218 p. Cloth. $1.25.]

Handy Tables. From "Thurston's Steam Engine Manual." For use in Laboratory Computations in Technical Schools. New York: John Wiley & Sons. [8vo. Cloth. $1.50.]

How to Become an Engineer, or the Theoretical and Practical Training Necessary in Fitting

for the Duties of the Civil Engineer. The Opinions of Eminent Authorities and the Courses of Study in the Technical Schools. By George W. Plympton, Am. Soc. C. E. New York: D. Van Nostrand Co. [Price 50 cents.]

How to Co-operate. By Herbert Myrick. New York: Orange Judd Co. [Cloth. $1.50.]

Laboratory Practice. A Series of Experiments on the Fundamental Principles of Chemistry. A companion volume to "The New Chemistry." By Prof. Josiah Parsons Cooke, LL. D. Harvard University. New York: D. Appleton & Co. [12 mo. Cloth. $1.]

Lessons on Common Minerals. New York: Teachers' Publishing Co.

Life of Sir John Franklin. By Captain A. H. Markham. [Great Explorers Series.] New York: Dodd, Mead & Co.

Mechanics for Beginners. By Rev. J. B. Lock. Part I. Dynamics and Statics. New York: Macmillan & Co.

Nature and Man in America. By Nathaniel Southgate Shaler. New York: Charles Scribner's Sons. [12 mo. Cloth. $1.50.]

Poor's Handbook of Investment Securities for the use of Bankers, Investors, Trust Institutions, and Railway Officials. Supplementing "Poor's Manual of Railroads." New York: H. V. & H. W. Poor. [Royal 8vo. 500 p. Cloth. $2.50.]

Principles and Practice of Plumbing. By S. S. Hellyer. New York: Macmillan & Co. [12 mo. Cloth. $1.25.]

Robert Fulton. By Prof. R. H. Thurston, of Cornell University. [In "Makers of America" series.] New York: Dodd, Mead & Co. [12mo Cloth. 75 cents.]

Stones for Building and Decoration. By George P. Merrill, Curator of Geology in the National Museum. Treating of Geographical Distribution of the Minerals. Physical and Chemical Properties of Building and Decorative Stones, Systematic Description of Rocks, Quarries and Quarry Regions, Methods of Quarrying and Workmen, Stone-Working Machines and Implements, Weathering, Selection, Protection and Preservation of Building Stone. New York: John Wiley & Sons. [8vo. Cloth. $5.]

The Arithmetic of Electricity. A manual of electrical calculations by arithmetical methods. By T. O'Conor Sloane, Ph. D. Illustrated. New York: Norman W. Henley & Co. [12mo. 138 p. Cloth. $1.]

The Cause of an Ice Age. By Sir Robert Ball, LL. D., F. R. S., Royal Astronomer of Ireland, author of "Starland." [The first volume in the Modern Science series, edited by Sir John Lubbock], New York: D. Appleton & Co. [12mo. Cloth. $1.]

The Condition of Labor: An Open Letter to Pope Leo XIII. By Henry George. New York: United States Book Co. [Paper. 30c.]

The Electromagnet and Electromagnetic Mechanism. By Sylvanus P. Thompson, D. Sc., F. R. S. New York: E. & F. N. Spon. [8vo. 450 p. Cloth. $6.]

The Fine Arts. By Prof. G. R. Brown. [University Extension Series.] New York: Charles Scribner's Sons. [Cloth. $1.]

The History of Modern Civilization. By Gustave Ducoudray. New York: D. Appleton & Co.

The Journal of the Iron and Steel Institute. No. 1, 1891. New York: E. & F. N. Spon. [8vo. 509 p., with 20 plates. Cloth. $6.]

The Last Great Naval War. By A. N. Seaforth. New York: Cassell Publishing Co. [75 cents.]

The "Metal Worker" Essays on House Heating, by Steam, Hot Water and Hot Air, with Introduction and Tabular Comparisons. Arranged for publication by A. O. Kittredge, Editor of the Metal Worker. New York: David Williams. [8vo. 288 p. Cloth. $2 50.]

The Practical Catechism. A Series of Direct Practical Questions and Answers on Subjects Connected with Engineering. By Robert Grimshaw. New York: John Wiley & Sons. [18mo. Cloth, $1.25.

The Practical Telephone Handbook and Guide to the Telephonic Exchange. By Joseph Poole. [12 mo. Cloth. 227 illustrations. $1.]

The Relation of Labor to the Law of To-day. By Lujo Brentano. New York: G. P. Putnam's Sons.

The Sextant and Other Reflecting Mathematical Instruments. By F. R. Brainard, U. S. N. New York: D. Van Nostrand Co. [50 cents.]

The Ventilation of Buildings. By Alfred R. Wolf, M. E. New York: The Author. [Pamphlet. 25 cents.]

Wooden Trestle Bridges. According to the Present Practice on American Railroads. Treating of Pile Bents, Pile Drivers, Framed Bents, Floor System, Bracing Trestles of all Kinds, Iron Details, Connection with Embankment and Protection against Accidents, Field Engineering and Erection, Preservation and Standard Specifications, Bills of Material, Records and Maintenance, Working Drawings. By Wolcott C. Foster, C. E. New York: John Wiley & Sons. [4to. Cloth. $5.